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Effectiveness of educator-oriented content courses

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Running Head: Effectiveness of Educator-Oriented Content Courses

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Introduction

The idea of teaching science strikes fear into the hearts and minds of many elementary teachers; however, as a core piece of the overall curriculum, they cannot escape teaching science. The courses taken at the university and the professional development classes taken on the job play a critical role in helping educators feel comfortable teaching science. Such courses also impact how the content is taught by introducing the best practices used in science teaching.

As a Basic Science Minor in the College of Education at the University of Northern Iowa, I have taken many science content courses and several courses that educate about the different methods of teaching elementary school science. Because of such classes I feel very prepared to teach science in the classroom, but not all teachers feel the same level of preparedness or comfort related to teaching science. Noticing this brought about the overall question "What is the effectiveness of educator-oriented science classes?" and the related survey question "How many science content courses did you take in college? Which were geared toward teachers?" An educator-oriented science content course covers various science disciplines and are designed specifically for elementary education majors. They present science and learning science via pedagogical approaches considered good practice for teaching science. I realized not all in-service educators took an educator-oriented science class at their university, but they have all had opportunities to take professional development courses about science. This led to the second survey question, "How many professional development classes have you taken in each content area: life science, physical science, and earth science?" If the educator had taken an educator-oriented science class in college, attended a professional development class about science, or done both would it make a difference in their level of comfort for teaching science? Would it affect the way an educator taught science in the classroom?

Reflecting on these questions I hypothesized that taking at least one educator-oriented science course in college or attending one professional development class would make the educator more comfortable teaching science. If an educator had taken more than one class or attended more than one professional development class, I hypothesized the educator would teach science in a more inquiry-based manner. I also hypothesized that the age of the educator would make a difference because the inquiry method of teaching science is relatively new and older educators may not have been exposed to that method while in college.

As explained in *Teaching science for all children: Methods for constructing understanding*, (Martin, Sexton, & Gerlovich, 2002) "inquiry refers to...the processes that children experience in which they develop testable ideas and construct understandings of real-world scientific ideas." (p. 8) In other words, the children actively investigate ideas to discover ideas or answers that are new to the children but are well known by teachers and scientists.

During a science lesson the teacher may have students do activities, investigations, or experiments. In this research, activities refers to exercises carried out by students which have very specific instructions but students may not know the expected outcome. In an investigation students are given materials but only enough explicit directions so they know the appropriate way to interact with the materials; the educator can tell what kind of records to keep but should not explain the concept before or during the investigation, thus using a learning cycle as a method of inquiry teaching. An experiment is done after the educator has explained the concept and is a way to check which students understand it. The educator gives very thorough directions to follow and students usually know the expected outcome for the experiment.

During their college career educators may have the option to take educator-oriented science content courses in place of the regular liberal arts core science content courses. The University of Northern Iowa Programs and Courses book for 2002 through 2004 describes the two educator-oriented liberal arts science content courses, Inquiry into Physical Science and Inquiry into Life Science, and the two most common regular science content courses accepted for liberal arts credit, General Chemistry I and General Biology I. Inquiry into Physical Science is summarized as "Inquiry-oriented introduction to concepts and processes drawn from chemistry, earth science, and physics using active investigation for those considering elementary education major. Integrated lecture/lab for four periods; plus one hour arranged" (*Programs and Courses*, p. 263) while General Chemistry I is summarized as "Structure of matter, its physical properties and laws describing them, the periodic table and its relation to atomic structure and chemical properties, and non-metallic elements and their compounds. Discussion, three periods; lab, three periods." (*Programs and Courses,* p. 268) Inquiry into Life Science is described as "Exploration of fundamental concepts of modern biology through active investigation. Content includes ecology, energy, diversity, and life cycles using a standards-based teaching approach. Integrate lecture/lab for four periods; plus one hour arranged," (*Programs and Courses*, p. 263) while General Biology I is described as "Study of organismic biology emphasizing evolutionary patterns and diversity of organisms and interdependency of structure and function in living systems. Discussion, three periods; lab, two periods." (*Programs and Courses*, p. 264) Overall, the major difference between the educator-oriented science content courses and the regular science content courses is the method in which they are taught. The educator-oriented science content courses are taught the way future educators should teach science in the classroom, while the regular content courses are taught in a lecture format usually followed by labs that verify the concept just taught.

As a Basic Science Minor I took the two above mentioned educator-oriented science content courses, Inquiry into Physical Science and Inquiry into Life Science, before taking more in depth content courses. The other three content courses required for the Basic Science Minor are Investigations in Physical Science, Investigations in Life Science, and Investigations in Earth Science. Investigations in Physical Science is described as an "introduction to concepts and theories of physical science and modeling effective teaching strategies related to elementary school level. Topics include electricity, magnetism, light, solutions, acids and bases, and states of matter. Discussion and/or lab, 5 periods." (*Programs and Courses*, p. 263) Investigations in Life Science is an "introduction to significant concepts and theories of life science and a model of effective teaching strategies related to elementary school level. Topics include diversity and classification, structure and function from cellular to organism level, human biology, and plant systems. Discussion and/or lab, 5 periods." (*Programs and Courses*, p. 267) Investigations in Earth Science "[introduces] significant concepts and theories of earth science an a model of effective teaching strategies related to elementary school level. Topics include geologic materials and processes acting on them and fundamentals of earth history, weather, and astronomy. Discussion and/or lab, 5 periods plus arranged." (*Programs and Courses*, p. 271) All together these classes introduce topics and concepts from the three major science areas. The professors teach these classes the way the future educators should teach science in their classrooms and provide many investigations that can be used at the elementary level.

After completing the three content courses, the next level of course work focuses on methods of teaching science: Experiences in Elementary School Science and Integrated Activities in Elementary School Science and Mathematics. Experiences in Elementary School Science aids in the "development of understanding science as an investigative process and how this relates to elementary science teaching. Seminar discussions and field experiences in applying knowledge of science content and pedagogy to working with elementary level students." (*Programs and Courses*, p. 263) Integrated Activities in Elementary School Science and Mathematics is "based on pedagogical investigation of manipulative materials and activities used in elementary science and mathematics followed by critical analysis using task analysis and research investigations."

Other science courses required for a Bachelor of Arts in Education are Teaching Elementary School Science and Environment, Technology, and Society. Teaching Elementary School Science is a methods course which "investigates current textbook series, trends, teaching materials, and appropriate instructional strategies for contemporary elementary school science programs." (*Programs and Courses*, p. 195) Environment, Technology, and Society, also known as Capstone, is a liberal arts core course that all students are required to complete before graduating. Capstone places an "emphasis on relationships and interactions of physical, biological, technological, and cultural components of environment. Study of selected interdisciplinary problems. Elaborates on student's previous university experience and develops environmental literacy." (*Programs and Courses*, p. 263) Completing all these courses in the Basic Science Minor has increased my knowledge of science content and teaching practices as well as increasing my comfort in teaching science.

<u>Definitions:</u>

Basic Science Minor: Course work for those pursuing K-6 classroom teacher licensure with an endorsement in Basic Science (K-6); includes Inquiries into Physical Science, Inquiries into Life Science, Investigations in Physical Science, Investigations in Life Science, Investigations in Earth Science, Experiences in Elementary School Science, Integrated Activities in Elementary School Science and Mathematics, and an additional four hours in chemistry or physics. (*Programs and Courses*, p. 119)

Educator-oriented course work: Science content courses that fulfill liberal arts core course requirements and are taught using effective teaching strategies that can be applied at the elementary level (*Programs and Courses*, p. 263, 267, 271)

Experiments: Science exercises that verify the concept just taught (Stefanich, p. 18)

Hands-on teaching: Teaching method which gets students directly involved in their learning by giving them "first-hand experience in science, utilizing cooperative, interactive methods" (Krapfl, p. 10)

Inquiry teaching: The processes that children experience in which they develop testable ideas and construct understandings of real-world scientific ideas (Martin, Sexton, & Gerlovich, p. 8)

Investigations: Student-planned science exercises which consist of conducting real-world research to collect and analyze so students can form inferences and conclusions based on the research (Martin, Sexton, & Gerlovich, p. 32)

Learning cycle: Method for planning lessons, teaching, learning, and developing curriculum which is consistent with the ways students learn; includes engagement, exploration, explanation, extensions, and evaluation. (Martin, Sexton, & Gerlovich, p. 11)

Liberal arts core courses: Exposes students to broad areas of knowledge and liberates students to further develop the knowledge, skills, and values necessary to live thoughtful, creative, and productive lives. At the University of Northern Iowa includes courses in civilizations and cultures; fine arts, literature, philosophy, and religion; natural science and technology; social science; communication essentials; and personal wellness. In the natural sciences category students must take one life science course, one physical science course, one hour of laboratory work in either life or physical science, and capstone. (*Programs and Courses*, p. 50)

Professional development course work: A continuous process in which educators engage in for intellectual professional growth related to the educators' work in schools (Krapfl, p. 29)

Review of Related Literature

Science is often educators' least favorite subject to teach. Many factors contribute to this attitude toward science: lack of materials, lack of time, low personal interest or confidence in teaching science, inadequate content knowledge, or limited teacher training. (Morely, 393-394) While the university cannot do much to help with the lack of materials or time, it can take steps to increase teachers' interest and confidence in teaching science, provide more or stronger science content courses, and spend more time training educators to teach science. The best way to achieve such an increase is to teach future educators in the same manner they should teach their students. "Future teachers should have ways of learning science similar to how their students will learn. If all their science courses are lecture and note-taking with cookbook labs, one methods course will have little effect." (Tilgner, 424) Instead, preservice teachers should take science-content courses that expose them to such best practices as the learning cycle and other hands-on, minds-on methods.

At the preservice level, it is the professors' responsibility to design the educator-oriented science content course to use best practices so the preservice teachers can refer back to their content course as a model for teaching science. Another helpful component of the educator-oriented science content courses is the dispensing of ideas or possible lessons preservice teachers can use in their future classrooms. Such ideas and lessons will prevent educators from resorting to the textbook to teach all science content. (Tilgner, 427)

Current educators may not be able to take educator-oriented science content courses, but they can take professional development classes related to science. Unfortunately, less than half of the current educators typically attend science professional development classes. Many of them do not attend the classes because their school district did not offer any incentives for going to the classes. (Morey, 390)

Even if educators attend professional development science classes, the new knowledge or methods may not stick with the educators. As with educator-oriented science content courses, the professional development classes or workshops should be taught in the same way the educators should teach their students. The best way to assure the application of the knowledge gained through a workshop or professional development class is to follow it up with additional mini-classes or workdays. (Krapfl, p. 14) All of this points to the need for teacher support and/or continuing education from science specialists.

Methodology

Research Instrument:

I began by drafting my survey with the help of Dr. Cherin Lee. Together we developed questions to measure the attitudes and practices of the survey participants. The final survey was two pages long with 22 questions. The questions fell into three categories: demographic data about the participants, information on the participant's science content background, and the participant's methods of teaching science. (See Appendix A for a complete survey.)

The first two questions are demographic: age and gender. This was included so the comfort level and methods of teaching can be compared by age (ex. responses of those 43 years old and under versus those 44 years old and over) and be compared by gender. The next few questions related to the educator's professional background. The total years taught might influence the educator's comfort level teaching overall as well as the methods used for teaching science. The number of years taught at current grade level could have a major impact on the educator's comfort level because s/he may not yet be familiar with the curriculum.

The next three questions are perhaps the most important in the survey. The first question establishes how many science content classes the educator took during university degree work and if those classes were geared toward educators. I hypothesize that the more content courses an educator took, the more comfortable s/he will feel teaching science. The next question determines the number of science related professional development classes the educator has taken. The professional development courses may impact both the educator's comfort level in teaching science and the methods used to teach science because the classes generally teach educators about best practices. The third question in this series asks the educator to rate his/her comfort level in teaching science. An educator's comfort level in teaching science may affect the use of learning cycles or other best practices.

The rest of the closed-ended questions focused on the educator's methods for teaching science. The first question in this series (#14) determines if activities, investigation, or experiments are used in the class while the second question determines the frequency of their use and the third question determines who performs them. The fourth question provides a label for what is done in the classroom (activities, investigations, or experiments) and an explanation of the label. The explanation of the label is important because it points to the educator's science teaching methods and philosophy. The final question in this series (#18) is another way to assess the educator's philosophy or methods. An educator that teaches with a learning cycle will place the activities/investigation/experiments as an introduction before talking about the concept and as a way to apply the concept. An experiment is typically done after talking about the concept and occasionally to apply the concept.

The results of the two open-ended questions were designed to provide educators with an opportunity to reflect on their teaching and to provide information about comfort level and methodology that the educators could not explain in the closed-ended questions. Also, if this survey is further studied by other university members, students or faculty, the answers from these two questions may be aid in the designing of future educator-oriented science classes.

After creating the survey I wrote the letter of consent for the Human Participants Review. (See Appendix B for a copy of the letter and consent form.) In the letter I told the potential participants what I hoped to discover from this research. I also explained there was no potential stress, penalties for withdrawal, or rewards. I also included instructions on how to fill out the survey and return it to me and informed them how and where the surveys would be stored along with the people who would have access to the results. I made sure they knew no one could be identified by the survey and that the surveys and consent forms would be kept separate to maintain anonymity. The final paragraph in the letter provided the potential participants with contact information for me and for my advisor Cherin Lee. I turned in the letter and survey to the Human Participants Review Board for their approval. After a period of time I contacted the review board and was informed that I needed to make a few minor changes before the letters and surveys could be sent out. I made the corrections and the edited letter and survey were approved for use by the Human Participants Review Board.

Population and Sample:

I wanted to sample teachers from across Iowa for this study. The teachers were both male and female of various ages from districts across the state, large and small. To make sure one part of Iowa was not under-represented I divided the state into four quadrants: northeast (north of Cedar Rapids and east of I-35), southeast (south of Cedar Rapids and east of I-35), northwest (north of Ames and west of I-35) and southwest (south of Ames and west of I-35). From each quadrant I selected 25 schools by searching school web sites on the Internet. I chose one educator that taught in the second grade through sixth grade range from each web site. Each quadrant had five educators from each grade, second through sixth, for a total of 25 randomly selected educators per quadrant or 100 elementary educators across the state.

I addressed and inserted surveys in one envelope to each educator. Each educator-addressed envelope was stuffed with the Human Participants Review letter, the informed consent permission paper, the survey, and a stamped envelope with my address so the survey could be mailed back to me. I mailed the first set of surveys on October 21, 2002 with a return date of November 11, 2002. Of the 100 surveys, two were returned as undeliverable as addressed and three were returned because the selected educators did not wish to participate in the survey. Twenty-six of the remaining surveys were returned, but five of the educators did not answer all of the questions and three others no longer taught within the second through sixth grade range. The final total return for the first survey mailing was 18 surveys.

Dr. Cherin Lee and I decided the sample size was not large enough to make any generalizations about the effectiveness of educator-oriented science classes. We decided to send out another set of surveys. I used the same Human Participants Review letter, informed consent permission paper, and survey that I used with the first mailing. This time, instead of searching for teachers over the Internet Dr. Lee gave me a list of forty-five northeast Iowa elementary teachers, all of whom taught science. I repeated the mailing process and mailed the envelopes on January 20, 2003 with a return date of February 11, 2003. Out of this set of surveys, 15 educators returned their surveys, all except two completed the entire survey and all but one fell within the second through sixth grade range. The total return of the second set of surveys was 12 surveys. The grand total of returned, complete, and usable surveys within the correct grade range was 30 surveys.

Data Presentation and Analysis

I sent out a total of 145 surveys between the two mailings and received 30 completed, usable surveys from participants that fell within the second grade through sixth grade range or 20.7% of the surveys. (See Appendix C for complete data.) From the usable surveys, 24 of the participants were female and 6 were male. Six of the participants were from southwest Iowa, three from southeast Iowa, five from northwest Iowa, and the remaining 16 were from northeast Iowa.

Table 1 Results by Gender

Female	24
Male	6

Table 2 Results by Region

Southwest Iowa	6
Southeast Iowa	3
Northwest Iowa	5
Northeast Iowa	16

The minimum age was 24 years old and the maximum age was 58 years old. The average age of the participants was 43 years old and the most common age was 42, with three participants at that age. Six of the participants were 24 to 28 years old, followed by a gap of eight years, and the rest of the 23 participants who answered this questions were 37 years old or older; one participant did not answer this question. The minimum total teaching experience was two years and the maximum was 37.5 years with an overall average of 16.62 years teaching experience. Of the total experience, the average years teaching at the current grade level was 11.03 years with a minimum of two years and a maximum of 30 years at the current grade level. Ten of the participants had not taught at any other grade level.

Table 3 Age, Total Years Teaching, and Years at Current Grade Level

	Average	Minimum	Maximum
Age	42.97	24	58
Total yrs. teaching	16.62	2	37.5
Yrs. at current grade level	11.03	2	30

Seventeen of the participants, or 56.67% of the total, had taken educator-oriented science content courses during their undergraduate programs, with the most common content course falling under the life science category. Nineteen of the participants, or 63.33%, have taken at least one professional development class about science, with the most common class falling under the life science category. The average level of comfort teaching science on the 1 to 10 Likert scale was eight; the minimum was three and the maximum was ten.

After compiling the overall data I began breaking it down in order to compare how different factors affect the educators and how they teach. I wanted to investigate the effects of the educator's age, the gender of the educator, and of course taking at least one educator-oriented science content course. I broke each category into two groups.

Age Comparisons(Appendix D):

In order to compare the age of the educators I divided the results into participants who were 43 years old or younger (n=15) and those over 43 years old (n=14); one participant did not answer this question. This division was based on 43 because it was both the median and mean. Aside from obvious differences in the mean age, the mean total years taught, and the years taught at the current grade level, the most notable differences occurred in the mean time spent teaching science each day and the percent of participants that took an educator-oriented science course in college.

The average difference between the two categories is 11.5 minutes each day. That means that students in an older educator's classroom are getting 34.5 hours more science education per week than those in a younger educator's classroom. I believe this difference occurs because younger teachers are still trying to establish their yearly routine to meet benchmarks and standards. They are focusing more attention on math and reading because those two content areas are more highly scrutinized by the general public.

Table 4 Average Minutes of Science Taught Each Day

	Monday	Tuesday	Wednesday	Thursday	Friday
≤43 years old (n=15)	37.60	36.93	33.93	26.93	34.93
>43 years old (n=14)	44.36	48.64	43.64	46.50	45.43

Almost 25 percent more educators age 43 or younger took educator-oriented science courses at their universities. The difference may be because educator-oriented science courses were not offered until recently or not everyone could remember if any courses outside of the College of Education were geared toward teachers. Even though there is a large discrepancy between the age groups in regard to taking educator-oriented science content courses, there is almost no difference between the age groups in regard to attending profession development science classes. About two-thirds of both groups attended some professional development science classes.

Table 5 Participants Taking Educator-Oriented Science and Professional Development Course Work

	Educator-Oriented Courses		Professional Development Classes	
	Number	Percent of Age Group	Number	Percent of Age Group
≤43 years old (n=15)	10	67%	10	67%
>43 years old (n=15)	6	43%	9	64%

The majority of the older group of educators said they consider the science exercises done by students to be investigations. In fact, twice as many older educators answered "investigations" as younger educators. One explanation for choosing investigation was "The children find out the answer by doing and finding out the answer [on their own]." However, the most common answer for younger educators was that they used all three kinds of exercises based on the needs of the lesson or unit. "A wide mixture of all three. We start investigating, apply that as experiments, and view activities," explained one educator.

When comparing where the educators place the activities/investigations/experiments in the chronology of a lesson, it was interesting to note that 6 of the 15 younger educators used them before explaining the concept, an important part of a learning cycle or inquiry-based lesson; only two of the 14 older educators did the same. The most common answer was that the activities/investigations/experiments were done at varying times in the lesson.

Looking at who performs the science exercises, teachers or students, it is important to note that the younger teachers performed the exercises more often than the older teachers. In other words, the older teachers let their students perform the science exercises more frequently than did the younger teachers. Eight of the younger teachers, or 53%, allowed the students to do the exercises while 10 of the older teachers, or 71%, let the students perform the exercises. The data on frequency of exercises and comfort level with teaching science were too similar to make any significant age comparisons.

Table 6 Science Exercises and Average Comfort Level

	Frequency of exercises	Average comfort level
≤43 years old (n=15)	Once a week: 10	8.17
>43 years old (n=14)	Once a week: 9	7.82

Gender Comparisons (Appendix E):

After analyzing the data for gender it was evident that women (n=24) greatly outnumbered men (n=6). Because the numbers were so far apart, I compared the same questions used in the age comparison based on percentage of participants answering that question. For example, 15 out of 24 women, or 62.50% of women, stated that they used activities/investigations/experiments once a week as did five out of six men, or 83.33% of men. The most notable differences between women and men occurred in the average age, which then affected both total years experience and years taught at current grade level. The number of earth science content classes taken and overall comfort teaching science also differed by gender.

Table 7 Average Age, Total Years Teaching, and Years at Current Grade

	Average Age	Ave. Total Yrs. Teaching	Ave. Yrs. at Current Grade
Women (n=24)	45.00	18.10	11.83
Men (n=6)	35.17	10.67	7.83

The average male educator is ten years younger than the average female educator. Since most teachers begin teaching in their early or middle twenties, the older female educators have been teaching about seven and one-half years longer than the younger male educators. The years taught at current grade level is related to both age and total years teaching because as an educator climbs up the seniority ladder, s/he is less likely to be moved around by the administration. Also, as an educator gains more experience at one grade level s/he becomes familiar with the curriculum and expectations for the grade level and will then be less likely to move. One possibility for the ten year age difference between the genders is that society assigned a harsh stigma to male elementary educators that deterred men from entering the education field until more recently.

Men took, on average, one more earth science content course in college than did women. Five out of six of the men took at least one earth science content course and 16 out of 24 women, or four-sixths of the women, took at least one course. However, a much larger difference is apparent in the percent that took two or more earth science content courses: only 3 of the 24 women accomplished that while four out of six men did the same. My hypothesis for the difference is that men tend to enjoy earth science courses more than women do.

Table 8 Earth Science Content Courses in College

	Ave. # Earth Sci. Courses	% Took 1 or more course	% Took 2 or more courses
Women (n=24)	0.88	66.67%	12.50%
Men (n=6)	2.00	83.33%	66.67%

Overall, women feel somewhat comfortable teaching science, but on average men feel very comfortable teaching science. On a scale of one to ten, men feel 1.35 points more comfortable teaching science. It is my hypothesis that this disparity is a result of complex interactions between girls and their guardians or educators during their school years. The girls may have been discouraged from working with science materials or ideas which may have caused them to dislike or fear science as a young girl. When they entered college they brought that dislike or fear with them and may have avoided taking science courses. This left them ill-prepared to teach science in the classroom so they do not feel as comfortable teaching science and they may accidentally transfer that discomfort with science to their students, continuing this cycle. Another possible result of this cycle is that female educators do not use activities/investigations/experiments as often as male educators.

Table 9 Average Comfort Level Teaching Science

	Average Comfort Level
Women (n=24)	7.73
Men (n=6)	9.08

The majority of both male and female educators use activities/investigations/experiments once a week or more. However, more women than men use those methods less frequently. Women were the only participants that used activities/investigations/experiments only once each month. As mentioned above, this could be the result of feeling ill-prepared or uncomfortable teaching science.

Table 10 Frequency of Activities/Investigations/Experiments

	Once a week	Once a month	Twice a month
Women (n=24)	62.50%	16.67%	20.83%
Men (n=6)	83.33%	0.00%	16.67%

The majority of both genders let their students do the activities instead of demonstrating the activities/investigations/experiments to the students. The most common answer selected for the label of what is done in science class was investigations. If one combines the results of those who chose investigations or investigations with another option, 66.67% of both male and female respondents call their science exercises investigations at some point. One participant explained her choice as "I want students to learn from their own investigations." Another said, "We sometimes use investigations to strengthen reasoning skills." The most common answer for the placement of activities/investigations/experiments was that the educators use them before teaching the concept, after teaching the concept, to apply the concept, and as a diversion or extension.

Table 11 Science Exercises and Participants Taking Educator-Oriented Content Courses

	Who performs exercises	Label of exercises	Placement of exercises	# took EOCC*
Women (n=24)	Students do them=62.50%	Investigations= 41.67%	Combination of all=62.50%	54.17%
Men (n=6)	Students do them=50.00%	Investigations= 33.33%	Combination of all=50.00%	66.67%

*EOCC=Educator-Oriented Content Courses

Educator-Oriented Content Classes (Appendix F):

The next comparison divided the educational background of the educators into two categories: those who had taken at least one educator-oriented science content course (n=17) and those who took a regular science content course (n=13). Upon further analysis I noticed a few interesting differences between the groups. First, a considerable difference between the average age of the participants caught my attention. There was also a difference in the amount time spent teaching science, the number of science content courses taken, and overall comfort teaching science based on the type of course taken. For this section the abbreviation EOCC will be used to represent Educator-Oriented Content Courses in the tables.

Looking at Table 12, the average age of those who took educator-oriented science content courses is 7.87 years younger than an educator who took a regular science content course. However, the average age was not correlated to the average total years teaching or to the years taught at the current grade level. One possible reason for this occurrence could be that educator-oriented science content courses were not offered until recently so earlier educators-in-training did not have the option to take those courses.

Table 12 Average Age, Total Years Teaching, and Years at Current Grade Level

	Average Age	Ave. Total Yrs. Teaching	Ave. Yrs. at Current Grade
Took EOCC	39.44	15.24	10.41
Took regular content course	47.31	18.42	11.85

On average, those who took educator-oriented science content courses teach science 6.05 minutes more each day (Table 13). That transfers to an average of 18.144 hours more per year for science instruction in a classroom with an educator who took an educator-oriented science content course. This could be occurring because those who took an educator-oriented science content course are more familiar with both the content and pedagogy at the elementary level than those who took a regular content course.

Table 13 Average Minutes of Science Taught Each Day

	Monday	Tuesday	Wednesday	Thursday	Friday
Took EOCC	41.59	46.88	43.35	36.29	39.82
Took regular content course	39.08	36.00	31.77	33.69	37.15

Those who took regular content courses took twice as many life science and physical science content courses as those who took educator-oriented content courses. I had expected the opposite to be true, but that is a result of my course work in completing a Basic Science Minor. My hypothesis for these results is that some of the preservice educators felt that the educator-oriented science content courses would be easier than the regular content courses, and that since they thought science was difficult, only took the minimum requirements of science. Another possibility is that far fewer educator-oriented content courses are offered to fulfill the natural science requirements for the liberal arts core course work.

Table 14 Average Number of Science Content Courses Taken at College

	Life Science	Physical Science	Earth Science
Took EOCC	1.65	0.76	1.06
Took regular content course	3.31	1.31	1.15

Those who took regular content courses felt more comfortable teaching science by 0.48 of a point on a ten point scale. Six of the 14 educators who took regular content courses felt very comfortable (10) teaching science while only two out of seventeen of the educators who took educator-oriented science courses answered the same way. I had expected these answers to be in favor of those who took educator-oriented science content courses. One possibility for the disparity, as mentioned above, is the reason they enrolled in the educator-oriented science content courses. Another reason could be that those who took regular content courses enrolled in more science courses so they may have a broader science knowledge base.

Table 15 Comfort Level Teaching Science

	Average Comfort Level	% who answered 10
Took EOCC	7.79	11.76%
Took regular content course	8.27	46.15%

I found several other statistics that surprised me. Of the four educators who only use activities/investigations/experiments once each month, three of them had taken educator-oriented science content courses. When asked who performs the activities/investigations/experiments, three-fourths of those who took regular content courses said students do them most of the time but only half of those who took educator-oriented science content courses answered the same. Looking at the answers to the question about where the activities/investigations/experiments are placed in the lesson, three of those who took regular content courses chose both before teaching the concept and for concept application; none of those who took educator-oriented courses chose that answer. I was truly surprised by this because that is the placement of activities/investigations/experiments in a learning cycle. I participated in, observed, and planned many learning cycles while completing my Basic Science Minor, but not all survey participants had those same opportunities. Also, not all universities teach their educator-oriented science content courses through the College of Natural Sciences as has been my experience at the University of Northern Iowa; some educator-oriented science content courses may have been taught through the College of Education which may give the preservice teachers a different perspective on the science content.

Discussion

The results of my survey research do not support my hypothesis that taking at least one educator-oriented science course in college would make the educator more comfortable teaching science. As described above, those who took such courses in college actually felt less comfortable teaching science and had fewer respondents that felt very comfortable, 10 on a one to ten scale, teaching science. I believe the biggest reason for this is the educators' reasons for taking an educator-oriented science content course. Too often I hear preservice teachers around me say they are taking such courses because the educator-oriented courses are easier or require less work than the other general education science content courses. If they take those courses with that mind set they are much less likely to feel comfortable learning science let alone teaching science. That mind set will also affect how they remember or interpret what they observe their professors doing and how their professors taught the course. In other words, even though they were exposed to inquiry teaching in the educator-oriented science content courses, they did not pick up on the professors' inquiry-based methodology. Through my Basic Science Minor course work I was able to participate in and observe learning cycles and other inquiry-based teaching methods in all of my content courses; the pedagogy was further discussed in the methods courses. Such long-term exposure to inquiry-based learning and teaching gave me an advantage over the participants who had only taken one educator-oriented science content course.

When comparing the educators based on their age, the difference in comfort teaching science is almost negligible. One of the biggest factors is the total years as an educator. If an educator started out very uncomfortable teaching science, s/he would become more comfortable teaching each topic the more often they taught it; after a few years the educator's comfort level has increased due to repetition. Along with total years teaching, the more experienced educators have had more opportunities to take professional development classes about science, which may increase educators' comfort level teaching science.

Despite the number of surveys I sent out, I do not feel the number of usable surveys returned provides enough information to draw appropriate conclusions. Future researchers for this topic might want to consider sending out larger number of surveys, offering a prize or reward for those who return the completed surveys, or administering the surveys over the phone. One advantage to interviewing over the phone is that the interviewer could make sure the educators only provide one response per question, which would make data analysis much easier.

The results of this survey did provide some insight into the effectiveness of educator-oriented science content courses, but it the results were the opposite of what I had hypothesized and expected. The results indicate that science education department heads and professors may want to analyze the structure of their classes to be sure they are meeting their objectives. However, the educator-oriented science courses I took at the University of Northern Iowa have increased my comfort level of teaching science.

References

Krapfl, L. (1997). *A program evaluation of an elementary science teacher preparation program.* Unpublished master's thesis, University of Northern Iowa, Cedar Falls.

Martin, R., Sexton, C., & Gerlovich, J. (2002). *Science for all children: Methods for constructing understanding* (2nd ed.). Boston, MA: Allyn and Bacon.

Morey, M. K. (1990). Status of science education in Illinois elementary schools. *Journal of Research in Science Teaching, 27*(4), 423-440.

Programs and courses. (2002). Cedar Falls, IA: University of Northern Iowa.

Stefanich, G. P. (1992). Reflections on elementary school science. *Journal of Elementary Science Education, 4*(2), 13-22.

Tilgner, P. (1990). Avoiding science in the elementary school. *Science Education, 74*(4), 421-431.

Appendix A:
Research Survey

1. Age: 2. Gender: M or F 3. Total years teaching:

4. School district: 5. Student population of school district:

6. Current grade level and number of years taught at this grade level:

7. Previous grade level(s) and number of years taught:

8. How many students do you have in your class this year?

9. How many minutes do you teach science each day, on average?

a)Monday	b)Tuesday	c)Wednesday	d)Thursday	e)Friday
______min	______min	______min	______min	______min

10. How many minutes or hours of science does your school district **require** you to teach each day or week?

11. Next to each subject, write the number of college science content courses you took in that area. If the class was geared toward teachers, circle the subject.

a) Biology/ Life Science b) Chemistry/ Physical Science c) Astronomy/ Earth Science

12. Next to each subject, write the number of **professional development** classes you have taken in the content area.

a)Biology/ Life Science b)Chemistry/ Physical Science c) Astronomy/ Earth Science

13. How comfortable do you feel teaching science? Mark the appropriate place on the scale.

very uncomfortable very comfortable

1 2 3 4 5 6 7 8 9 10

14. Do you use activities and/or investigations/experiments in your science class? (Circle one.)
Yes No

15. If you answered "Yes" to the previous question, how frequently do you do so? (Circle one.)
Once a week Once a month Twice a month

16. Are the activities and/or investigations/experiments done as a demonstration or do students do them?
Demonstrations Students do them

17. If the students do the activities and/or investigations/experiments, do you consider them to be:
a) activities b) investigations c) experiments
Please explain your choice.

18. Where do you place the activities and/or investigations/experiments? Circle all that apply.
a) as an introduction before you talk about the content/concept
b) after you have talked about the content/concept
c) to apply the content/concept
d) for the purpose of enrichment/diversion from regular classroom content

19. Do you teach all subjects or do you specialize in one or two subjects?

20. If so, in which subjects do you specialize?

21. What do you feel are your weaknesses with regard to teaching science?

22. What do you feel are your strengths with regard to teaching science?

Appendix B:
Informed Consent

UNIVERSITY OF NORTHERN IOWA
HUMAN PARTICIPANTS REVIEW
INFORMED CONSENT

The Effectiveness of Educator Oriented Science Classes

Joslyn Burt
Dr. Cherin Lee

You have been selected to participate in a research project conducted through the University of Northern Iowa. The University requires that you give your signed agreement to participate in this project. The following information is provided to help you make an informed decision whether or not to participate.

My name is Joslyn Burt and I am a senior elementary/middle level education major with a basic science minor. I am conducting this survey to be used for my senior thesis to fulfill the requirements of my Presidential Scholarship. After taking many science classes in my college career, my goal for this survey is to discover the effectiveness of science classes geared specifically toward education majors, specifically in comfort of teaching science and activities/investigations/experiments used in the classroom. The data collected from this research will be used in a presentation for University faculty and students.

Your part in this study should not cause you any discomfort or psychological stress. You will not be penalized in any way for not participating in or withdrawing from this research. You will not receive any cash, gift, or other benefits from participating in this survey. However, you will be able to examine your teaching methods and provide useful information to university faculty designing science courses and teacher preparation programs

Please follow the instructions given for each question on the survey. It will take you approximately ten to fifteen minutes to fill out the survey. When you finish the survey, place it in the pre-addressed envelope and mail it to me by November 11. Also include a signed copy of the colored consent letter.

The only identifying information will be the name of the school district. I will keep a record of the schools that receive surveys, but I will not record the name of the teacher. When I receive the surveys I will place them in my lockable filing cabinet. Only my advisor Cherin Lee and I will have access to the completed surveys. The statistics derived from the surveys will be used in a presentation for University faculty and students. The statistics may also be used in future research by the Science Education Department, but any personal or identifying information will be destroyed.

If you have any questions about your participation in this research or about an item on the survey, I may be reached by phone at (319)222-2995 or by email at josburt@uni.edu or you can contact my advisor at cherin.lee@uni.edu. Cherin or I can also answer questions regarding confidentiality, future use of the information, or general inquiries about the study.

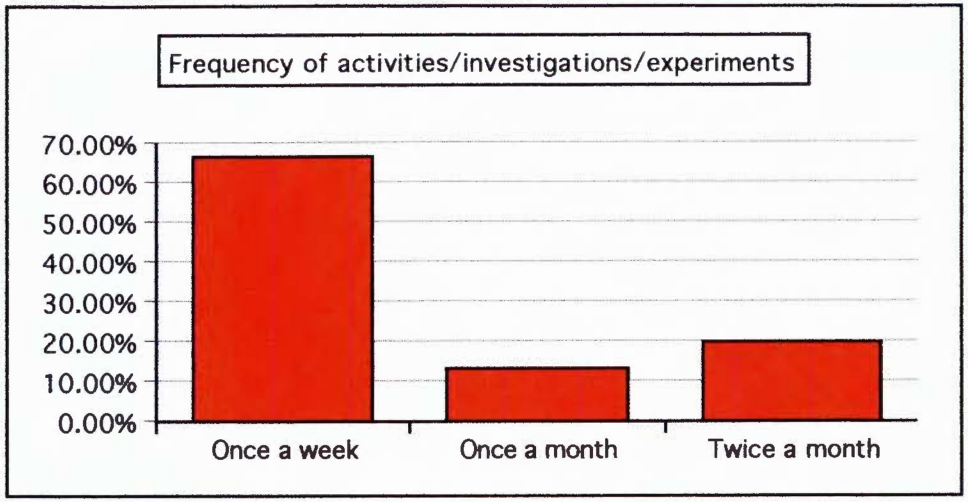
Appendix C:
Survey Data

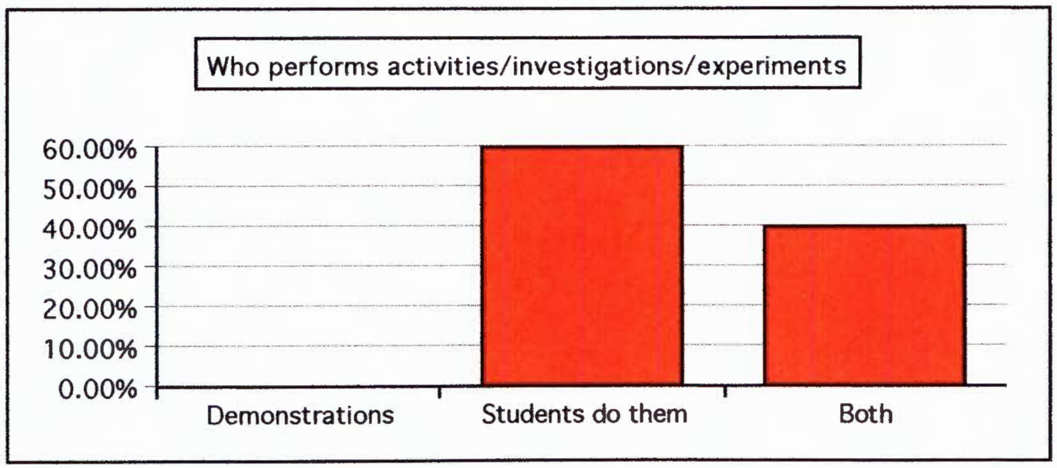
	A	B	C	D	E	F	G	H
1	Returned?	School	City	Grade level	Q1	Q2	Q3	Q5
2	y	Shenandoah El.	Shenandoah	3	47	0	20	na
3	y	West Ridge El.	Harlan	4	48	0	28	1700
4	y	AHST Middle	Avoca	5	46	0	24	600
5	y	Mount Ayr El.	Mount Ayr	5	24	0	2	700
6	y	Atlantic Middle	Atlantic	6	27	1	5	1400
7	y	Elk Horn-Kimballton Middle	Elk Horn	6	42	0	7	312
8	y	Woodrow Wilson El.	Newton	4	24	1	2	na
9	y	Mediapolis El.	Mediapolis	3/4	42	0	18	900
10	y	Smart Intermediate	Davenport	6	58	0	18	700 @ school
11	y	North El.	Storm Lake	2	na	0	12	na
12	y	Kinsey El.	Sioux Center	2	40	0	18	800
13	y	Ruthven-Ayrshire El	Ruthven	2	53	0	26	300
14	y	Sentral El.	Fenton	2	57	0	27	280
15	y	Prairie Valley Middle	Gowrie	5	43	0	19	850
16	y	North El.	Hampton	2	25	0	2.5	1300
17	y	McKinstry El.	Waterloo	4	28	0	4	na
18	y	Tipton El.	Tipton	5	42	1	4	840
19	y	West Middle	Anamosa	6	52	1	31	1200
20	y	Dike-New Hartford	Dike	5	40	0	16	787
21	y	Cedar Falls	Cedar Falls	2	37	0	15	na
22	y		Waterloo	3	58	0	37.5	420
23	y	North Cedar	Cedar Falls	6	25	1	2	na
24	y	Janesville	Janesville	6	50	0	15	250
25	y		Cedar Falls	4	57	0	30	376
26	y	Independence Comm.	Independence	6	45	0	4	1550
27	y		Cedar Falls	4	38	0	16	na
28	y		Cedar Falls	2	54	0	21	na
29	y	Wapsie Valley	Fairbank	5/6	47	0	25	600
30	y		Waterloo	5	56	0	29.5	12000
31	y		Cedar Falls	4	41	1	20	na
32								
33	AVERAGE				42.97	6.00	16.62	
34						0=f, 1=m		
35								
36								
37								

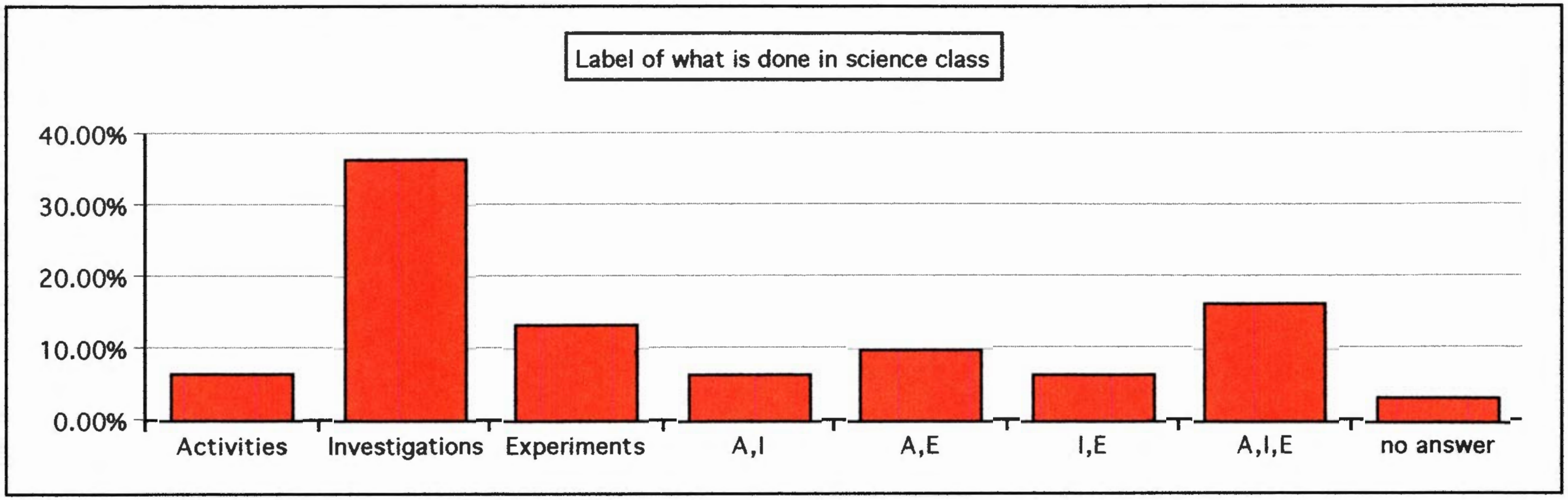
	I	J	K	L	M	N	O	P	Q
1	Q6	07	Q8	Q9a	Q9b	Q9c	Q9d	Q9e	Q10
2	12	Title k-3: 2;	20	15	15	15	15	15	none
3	23	Middle School:	22	30	30	30	30	30	30/day
4	13	k-6MD-SCI: 6:	24	45	45	45	45	45	none
5	2	0	20	40	40	40	40	40	none
6	5	na	28	42	42	42	42	42	42 min/day
7	4	high school: 3	150	45	45	45	45	45	none
8	2	0	24	45	45	30	45	45	30-45
9	5	4th: 13	21	0	60	0	60	0	na
10	18	6-7-8, 4-5	23	50	50	50	50	50	50-55
11	7.5	3rd: 2.5; 4th:	na	30	30	30	0	0	none
12	18	0	21	30	30	30	30	30	90 min/week
13	23	1st: 3	16	20	20	20	20	20	none
14	9	Kdg: 10; PreK:	15	20	20	20	20	20	none
15	2	6th: 12; 7/8:	21	42	42	42	42	42	210 min/week
16	2.5	0	19	30	30	30	30	30	2.5 hrs/week
17	2	3rd: 2	22	40	40	0	40	30	60 min 3 times
18	4	0	22	45	0	45	0	45	none
19	16	5th: 15	116	18	18	18	18	18	90/week
20	16	0	22	40	30	40	30	40	none
21	4	12345	20	30	30	45	0	30	none
22	25	1st: 2, 2nd: 8,	22	35	35	35	35	35	90 min/wk
23	2	0	20	60	30	30	0	30	na
24	6	4/5: 3	27	43	43	43	43	43	43/day
25	30	0	23	0	45	45	0	45	none
26	4	0	116	230	230	230	230	230	230/day
27	15	6th:1	20	30	45	45	0	45	150/week
28	12	Sp. Ed k-6: 8;	22	30	45	30	60	30	30/day
29	25	0	19	30	30	30	30	0	none
30	6	2nd: 11; 6-8:	28	55	55	0	55	55	45/day
31	18	5th: 1; adult	21	45	45	45	0	30	na
32									
33	11.03		32.55	40.50	42.17	38.33	35.17	38.67	
34									
35									
36									
37									

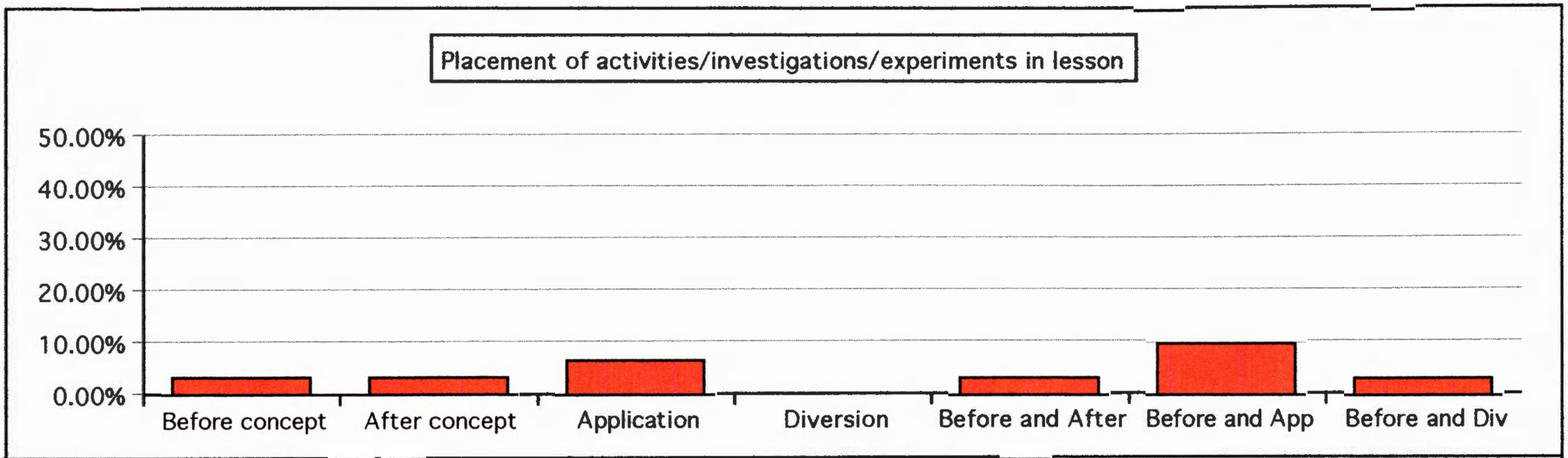
	R	S	T	U	V	W	X	Y	Z
1	Q11 (Y/N)	Q11a	Q11b	Q11c	Q12 (Y/N)	Q12a	Q12b	Q12c	Q13
2	1	2	1	1	0	0	0	0	6
3	0	1	1	1	1	1	0	0	5.5
4	0	1	1	1	1	2	0	0	10
5	1	1	1	1	0	0	0	0	5
6	1	2	1	3	0	0	0	0	8
7	0	5	2	1	1	6	0	0	9
8	1	1	1	1	0	0	0	0	7.5
9	1	4	0	1	1	2	0	0	8
10	0	5	1	3	0	0	0	0	10
11	1	2	0	0	0	0	0	0	8
12	1	1	0	1	1	2	1	1	9
13	0	4	2	0	1	2	0	0	9
14	0	1	0	1	1	1	0	1	7
15	1	0	0	0	1	1	0	1	7
16	1	1	0	0	0	0	0	0	6
17	0	3	2	0	1	1	0	0	6
18	0	5	3	3	0	0	0	0	10
19	1	3	2	2	1	6	2	3	9
20	0	4	1	1	1	2	1	3	8
21	1	1	0	2	1	0	0	2	9
22	1	1	1	1	0	0	0	0	9
23	1	3	3	3	1	1	0	1	10
24	0	3	3	1	1	1	0	0	3
25	1	2	1	1	1	6	0	0	7
26	1	2	2	1	0	0	0	0	7
27	1	1	0	0	1	3	1	2	10
28	0	2	1	0	1	1	0	1	10
29	1	1	0	0	1	6	6	0	7
30	0	5	0	3	0	0	0	0	10
31	0	4	0	0	1	4	0	0	10
32	y=1, n=0								
33	17.00	2.37	1.00	1.10	19.00	1.60	0.37	0.50	8.00
34	56.67%				63.33%				
35									
36									
37									

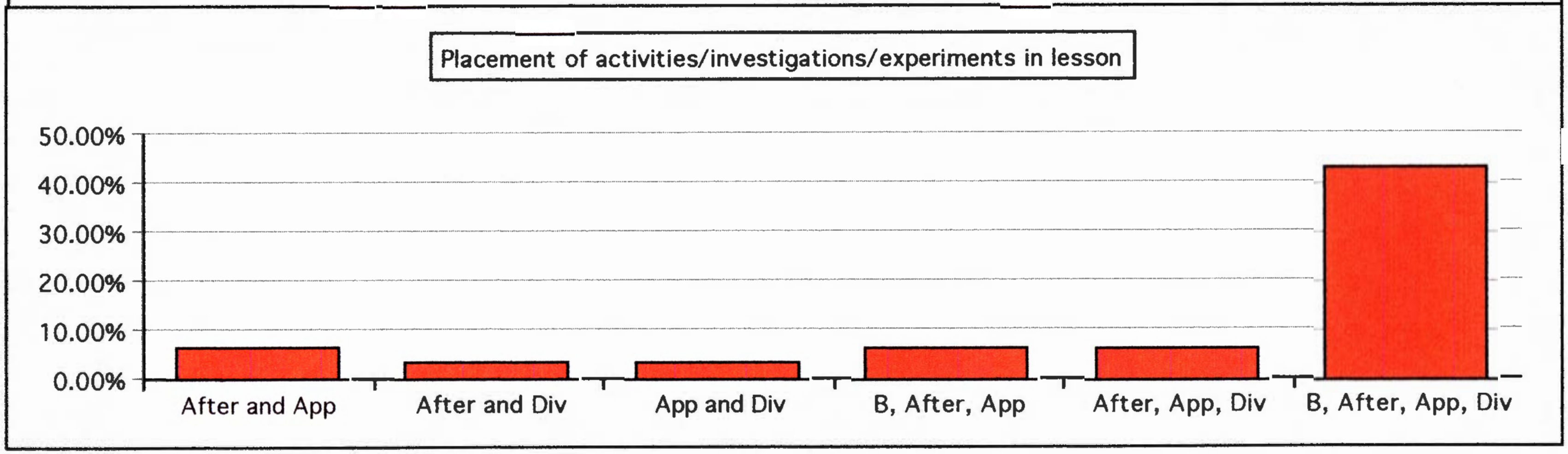
	AA	AB	AC	AD	AE	AF	AG	AH	AI
1	Q14	Q15	Q16	Q17	Q18	Q19	Q20	Q21	Q22
2	y	b	c	a	a,d	all	n/a	time,	choosing
3	y	c	c	b,c	a,b,c,d	all	n/a	not	involve
4	y	a	b	na	c	specialize	Science and Enç	none	Love to
5	y	b	c	c	c,d	specialize	Math and Scien	new texts	rich
6	y	a	c	a,b,c	a,b,c,d	specialize	science, social	physics	life science
7	y	a	b	a,b,c	a,b,c,d	specialize	science	chemistry	life science
8	y	a	c	a,c	a,b,c,d	all	n/a	too much to	let students
9	y	c	b	a	a,b,c	all	n/a	time	make it
10	y	a	c	c	b,d	specialize	science	none	Earth,
11	y	c	c	a,c	a,b,c,d	all	n/a	time; knowing	enjoy science
12	y	a	b	a,b,c	a,b,c,d	all	n/a	upper level	elementary
13	y	b	c	b	b,c	all	n/a	physical	life science
14	y	a	b	b	a,b,c,d	all	n/a	Time	more
15	y	b	b	b	a,b,c,d	specialize	science, math	applying to	curiousity and
16	y	a	c	a,b,c	a,b,c	all	n/a	not spent	use
17	y	c	c	a,c	a,c	all	n/a	not enough	open to new
18	y	a	b	c	c	all	n/a	not enough	large
19	y	c	b	b	a,b,c,d	all	chemistry/phy	astronomy,	
20	y	a	b	b	a,c	all	n/a	length of unit;	hands-on;
21	y	a	c	b	a,b	all	n/a	materials,	interest,
22	y	a	b	b	b,c,d	all	n/a	time,	attend
23	y	a	c	b	b,c	all	n/a	time	good content
24	y	a	b	b	a	all	n/a	content	fun; easy to
25	y	a	b	c	b	all	n/a	background in	enjoy
26	y	c	b	b	a,b,c,d	specialize	science	staying up to	variety;
27	y	a	b	a,b,c	a,b,c,d	all	n/a	time	integrating
28	y	a	b	a,b	b,c,d	all	n/a	time	knowledge of
29	y	a	b	b	a,b,c,d	specialize	math and scienc	small room;	enthusiasm
30	y	a	b	b	a,b,c,d	specialize	language, math	time;	comfort with
31	y	a	b	b,c	a,c	all	n/a	solar system	great mentors;
32									
33									
34									
35									
36									
37									


Frequency of activities/investigations/experiments
70.00%
60.00%
50.00%
40.00%
30.00%
20.00%
10.00%
0.00%
Once a week
Once a month
Twice a month


Who performs activities/investigations/experiments
60.00%
50.00%
40.00%
30.00%
20.00%
10.00%
0.00%
Demonstrations
Students do them
Both


Label of what is done in science class
40.00%
30.00%
20.00%
10.00%
0.00%
Activities
Investigations
Experiments
A,I
A,E
I,E
A,I,E
no answer


Placement of activities/investigations/experiments in lesson
50.00%
40.00%
30.00%
20.00%
10.00%
0.00%
Before concept
After concept
Application
Diversion
Before and After
Before and App
Before and Div


Placement of activities/investigations/experiments in lesson
50.00%
40.00%
30.00%
20.00%
10.00%
0.00%
After and App
After and Div
App and Div
B, After, App
After, App, Div
B, After, App, Div

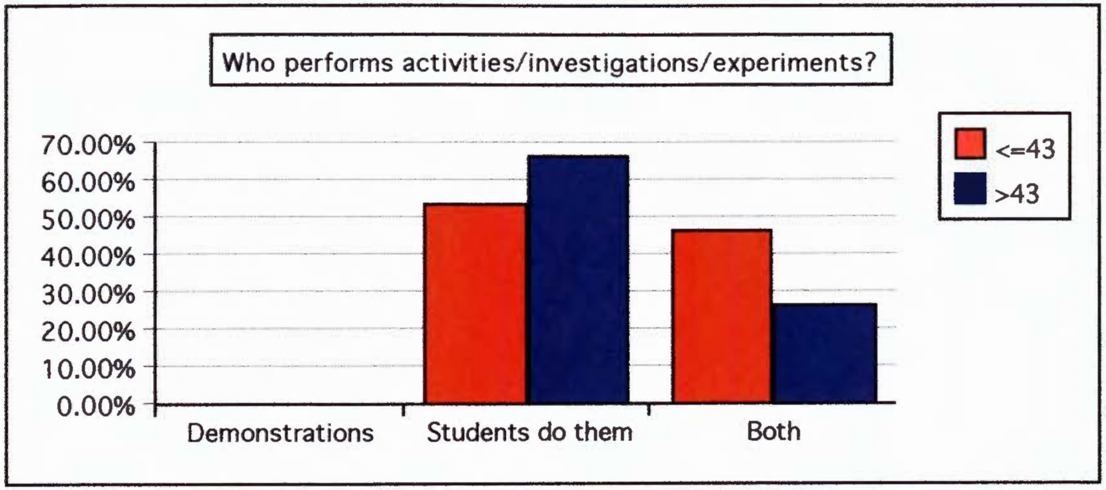
Appendix D:
Age Comparison Data

	A	B	C	D	E	F	G	H	I
1	y	Mount Ayr El.	Mount Ayr	5	24	0	2	700	2
2	y	Atlantic Middle	Atlantic	6	27	1	5	1400	5
3	y	Elk Horn-Kimba	Elk Horn	6	42	0	7	312	4
4	y	Woodrow Wilso	Newton	4	24	1	2	na	2
5	y	Mediapolis El.	Mediapolis	3/4	42	0	18	900	5
6	y	Kinsey El.	Sioux Center	2	40	0	18	800	18
7	y	Prairie Valley M	Gowrie	5	43	0	19	850	2
8	y	North El.	Hampton	2	25	0	2.5	1300	2.5
9	y	McKinstry El.	Waterloo	4	28	0	4	na	2
10	y	Tipton El.	Tipton	5	42	1	4	840	4
11	y	Dike-New Hartf	Dike	5	40	0	16	787	16
12	y	Cedar Falls	Cedar Falls	2	37	0	15	na	4
13	y	North Cedar	Cedar Falls	6	25	1	2	na	2
14	y		Cedar Falls	4	38	0	16	na	15
15	y		Cedar Falls	4	41	1	20	na	18
16							10.03		6.77
17									
18	Returned?	School	City	Grade level	Q1	Q2	Q3	Q5	Q6
19									
20									
21	y	Shenandoah El.	Shenandoah	3	47	0	20	na	12
22	y	West Ridge El.	Harlan	4	48	0	28	1700	23
23	y	AHST Middle	Avoca	5	46	0	24	600	13
24	y	Smart Intermed	Davenport	6	58	0	18	700 @ school	18
25	y	Ruthven-Ayrsh	Ruthven	2	53	0	26	300	23
26	y	Sentral El.	Fenton	2	57	0	27	280	9
27	y	West Middle	Anamosa	6	52	1	31	1200	16
28	y		Waterloo	3	58	0	37.5	420	25
29	y	Janesville	Janesville	6	50	0	15	250	6
30	y		Cedar Falls	4	57	0	30	376	30
31	y	Independence C	Independence	6	45	0	4	1550	4
32	y		Cedar Falls	2	54	0	21	na	12
33	y	Wapsie Valley	Fairbank	5/6	47	0	25	600	25
34	y		Waterloo	5	56	0	29.5	12000	6
35							24.00		15.86
36									
37									

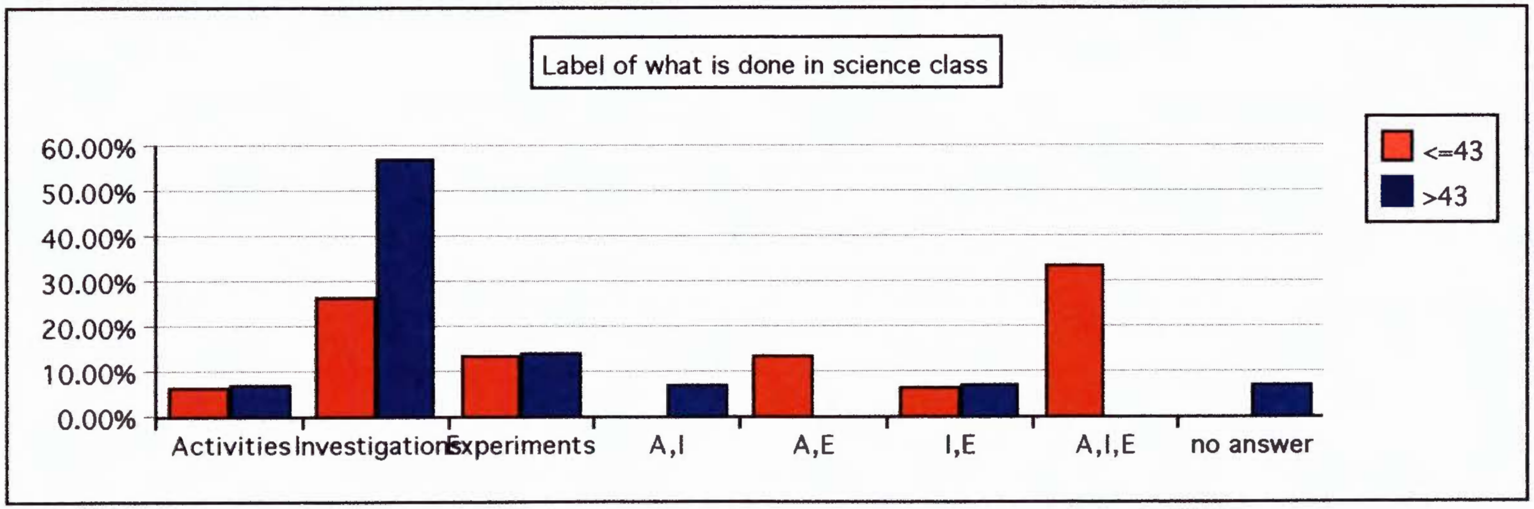
	J	K	L	M	N	O	P	Q	R
1	0	20	40	40	40	40	40	none	1
2	na	28	42	42	42	42	42	42 min/day	1
3	high school: 3	150	45	45	45	45	45	none	0
4	0	24	45	45	30	45	45	30-45	1
5	4th: 13	21	0	60	0	60	0	na	1
6	0	21	30	30	30	30	30	90 min/week	1
7	6th: 12; 7/8:	21	42	42	42	42	42	210 min/week	1
8	0	19	30	30	30	30	30	2.5 hrs/week	1
9	3rd: 2	22	40	40	0	40	30	60 min 3 times	0
10	0	22	45	0	45	0	45	none	0
11	0	22	40	30	40	30	40	none	0
12	12345	20	30	30	45	0	30	none	1
13	0	20	60	30	30	0	30	na	1
14	6th:1	20	30	45	45	0	45	150/week	1
15	5th: 1; adult	21	45	45	45	0	30	na	0
16		30.07	37.60	36.93	33.93	26.93	34.93		10.00
17									66.67%
18	Q7	Q8	Q9a	Q9b	Q9c	Q9d	Q9e	Q10	Q11 (Y/N)
19									
20									
21	Title k-3: 2;	20	15	15	15	15	15	none	1
22	Middle School:	22	30	30	30	30	30	30/day	0
23	k-6MD-SCI: 6;	24	45	45	45	45	45	none	0
24	6-7-8, 4-5	23	50	50	50	50	50	50-55	0
25	1st: 3	16	20	20	20	20	20	none	0
26	Kdg: 10; PreK:	15	20	20	20	20	20	none	0
27	5th: 15	116	18	18	18	18	18	90/week	1
28	1st: 2, 2nd: 8,	22	35	35	35	35	35	90 min/wk	1
29	4/5: 3	27	43	43	43	43	43	43/day	0
30	0	23	0	45	45	0	45	none	1
31	0	116	230	230	230	230	230	230/day	1
32	Sp. Ed k-6: 8;	22	30	45	30	60	30	30/day	0
33	0	19	30	30	30	30	0	none	1
34	2nd: 11; 6-8:	28	55	55	0	55	55	45/day	0
35		35.21	44.36	48.64	43.64	46.50	45.43		6.00
36									42.86%
37									

	S	T	U	V	W	X	Y	Z	AA
1	1	1	1	0	0	0	0	5	y
2	2	1	3	0	0	0	0	8	y
3	5	2	1	1	6	0	0	9	y
4	1	1	1	0	0	0	0	7.5	y
5	4	0	1	1	2	0	0	8	y
6	1	0	1	1	2	1	1	9	y
7	0	0	0	1	1	0	1	7	y
8	1	0	0	0	0	0	0	6	y
9	3	2	0	1	1	0	0	6	y
10	5	3	3	0	0	0	0	10	y
11	4	1	1	1	2	1	3	8	y
12	1	0	2	1	0	0	2	9	y
13	3	3	3	1	1	0	1	10	y
14	1	0	0	1	3	1	2	10	y
15	4	0	0	1	4	0	0	10	y
16	2.40	0.93	1.13	10.00	1.47	0.20	0.67	8.17	
17									
18	Q11a	Q11b	Q11c	Q12 (Y/N)	Q12a	Q12b	Q12c	Q13	Q14
19									
20									
21	2	1	1	0	0	0	0	6	y
22	1	1	1	1	1	0	0	5.5	y
23	1	1	1	1	2	0	0	10	y
24	5	1	3	0	0	0	0	10	y
25	4	2	0	1	2	0	0	9	y
26	1	0	1	1	1	0	1	7	y
27	3	2	2	1	6	2	3	9	y
28	1	1	1	0	0	0	0	9	y
29	3	3	1	1	1	0	0	3	y
30	2	1	1	1	6	0	0	7	y
31	2	2	1	0	0	0	0	7	y
32	2	1	0	1	1	0	1	10	y
33	1	0	0	1	6	6	0	7	y
34	5	0	3	0	0	0	0	10	y
35	2.36	1.14	1.14	9.00	1.86	0.57	0.36	7.82	
36									
37									

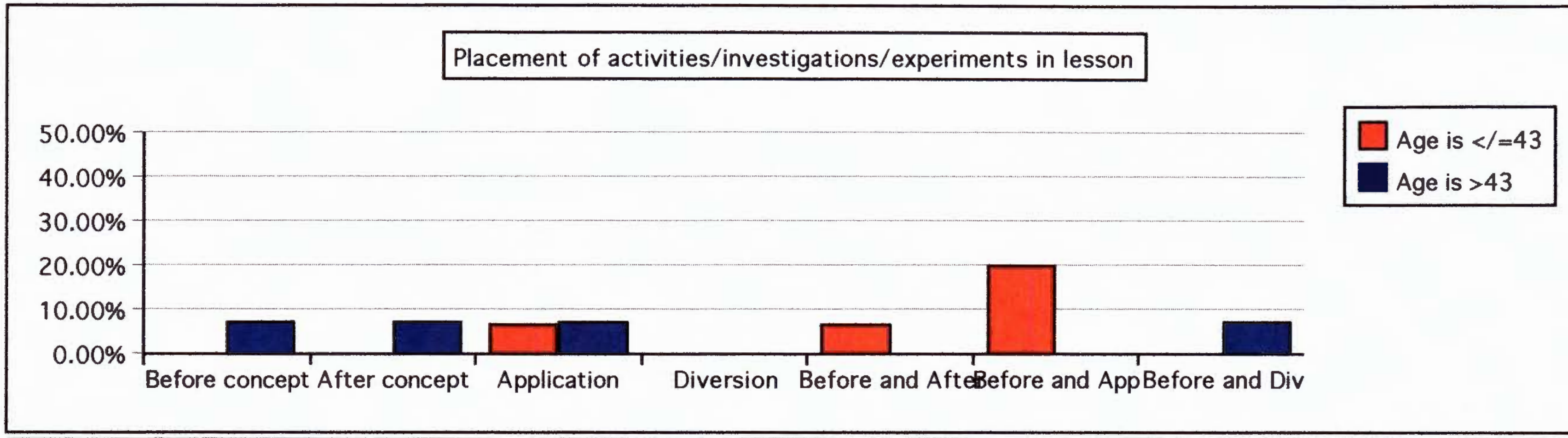
	AB	AC	AD	AE	AF	AG	AH	AI
1	b	c	c	c,d	specialize	Math and Scien	new texts	rich
2	a	c	a,b,c	a,b,c,d	specialize	science, social	physics	life science
3	a	b	a,b,c	a,b,c,d	specialize	science	chemistry	life science
4	a	c	a,c	a,b,c,d	all	n/a	too much to	let students
5	c	b	a	a,b,c	all	n/a	time	make it
6	a	b	a,b,c	a,b,c,d	all	n/a	upper level	elementary
7	b	b	b	a,b,c,d	specialize	science, math	applying to	curiousity and
8	a	c	a,b,c	a,b,c	all	n/a	not spent	use
9	c	c	a,c	a,c	all	n/a	not enough	open to new
10	a	b	c	c	all	n/a	not enough	large
11	a	b	b	a,c	all	n/a	length of unit;	hands-on;
12	a	c	b	a,b	all	n/a	materials,	interest,
13	a	c	b	b,c	all	n/a	time	good content
14	a	b	a,b,c	a,b,c,d	all	n/a	time	integrating
15	a	b	b,c	a,c	all	n/a	solar system	great mentors;
16								
17								
18	Q15	Q16	Q17	Q18	Q19	Q20	Q21	Q22
19								
20								
21	b	c	a	a,d	all	n/a	time,	choosing
22	c	c	b,c	a,b,c,d	all	n/a	not	involve
23	a	b	na	c	specialize	Science and Enç	none	Love to
24	a	c	c	b,d	specialize	science	none	Earth,
25	b	c	b	b,c	all	n/a	physical	life science
26	a	b	b	a,b,c,d	all	n/a	Time	more
27	c	b	b	a,b,c,d	all	chemistry/phy	astronomy,	
28	a	b	b	b,c,d	all	n/a	time,	attend
29	a	b	b	a	all	n/a	content	fun; easy to
30	a	b	c	b	all	n/a	background in	enjoy
31	c	b	b	a,b,c,d	specialize	science	staying up to	variety;
32	a	b	a,b	b,c,d	all	n/a	time	knowledge of
33	a	b	b	a,b,c,d	specialize	math and scienc	small room;	enthusiasm
34	a	b	b	a,b,c,d	specialize	language, math	time;	comfort with
35								
36								
37								

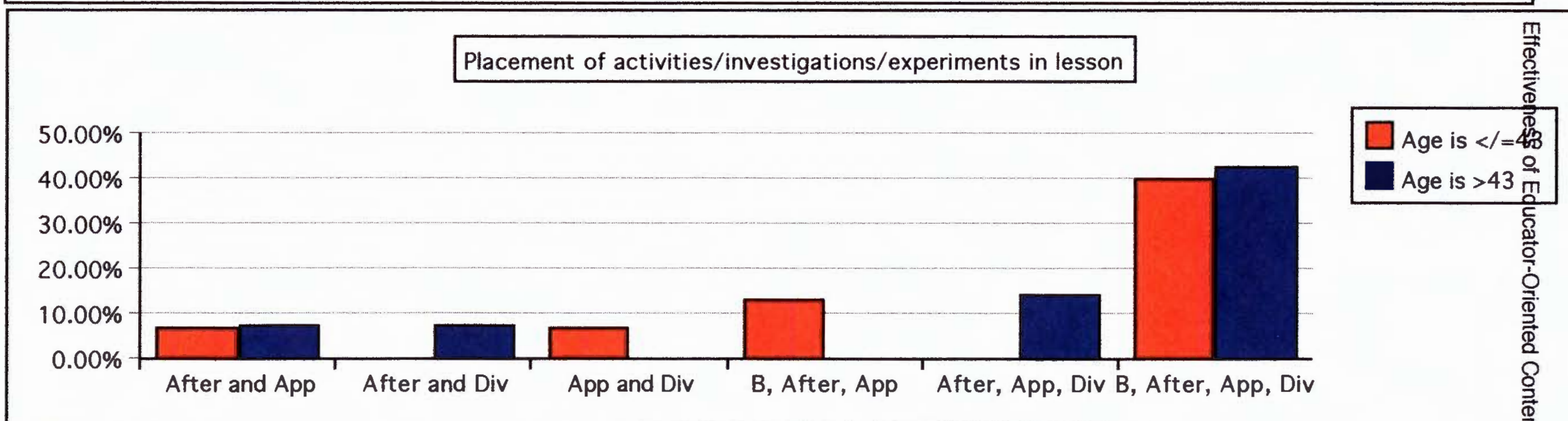


This graph shows how who performs activities/investigations/experiments is affected by the age of the educator.



This graph shows how the label of what is done in science class is affected by the age of the educators.





These two graphs show how age affects the placement of activities/investigations/experiments in a lesson.

Appendix E:
Gender Comparison Data

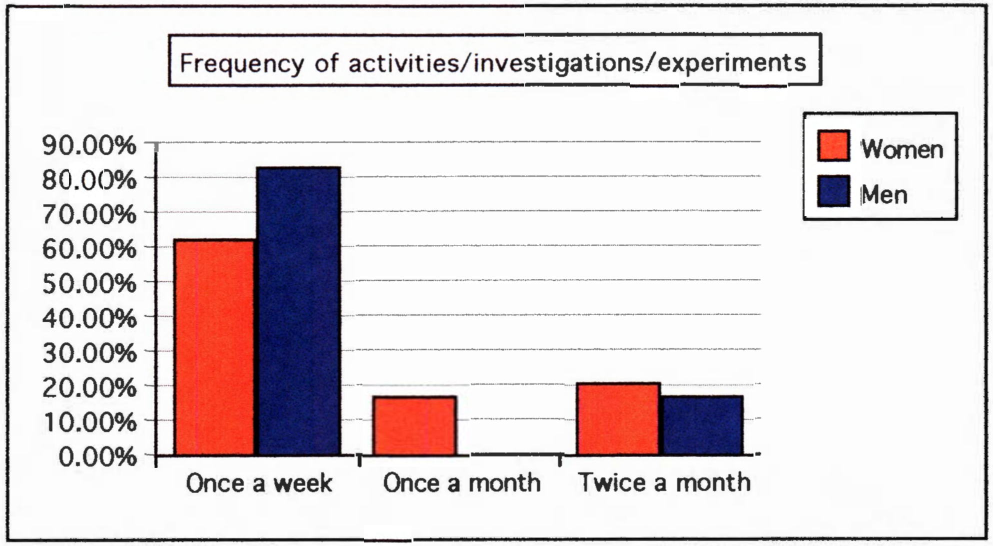
	A	B	C	D	E	F	G	H	I
1	y	Shenandoah El.	Shenandoah	3	47	0	20	na	12
2	y	West Ridge El.	Harlan	4	48	0	28	1700	23
3	y	AHST Middle	Avoca	5	46	0	24	600	13
4	y	Mount Ayr El.	Mount Ayr	5	24	0	2	700	2
5	y	Elk Horn-Kimba	Elk Horn	6	42	0	7	312	4
6	y	Mediapolis El.	Mediapolis	3/4	42	0	18	900	5
7	y	Smart Intermec	Davenport	6	58	0	18	700 @ school	18
8	y	North El.	Storm Lake	2	na	0	12	na	7.5
9	y	Kinsey El.	Sioux Center	2	40	0	18	800	18
10	y	Ruthven-Ayrsh	Ruthven	2	53	0	26	300	23
11	y	Sentral El.	Fenton	2	57	0	27	280	9
12	y	Prairie Valley M	Gowrie	5	43	0	19	850	2
13	y	North El.	Hampton	2	25	0	2.5	1300	2.5
14	y	McKinstry El.	Waterloo	4	28	0	4	na	2
15	y	Dike-New Hartf	Dike	5	40	0	16	787	16
16	y	Cedar Falls	Cedar Falls	2	37	0	15	na	4
17	y		Waterloo	3	58	0	37.5	420	25
18	y	Janesville	Janesville	6	50	0	15	250	6
19	y		Cedar Falls	4	57	0	30	376	30
20	y	Independence C	Independence	6	45	0	4	1550	4
21	y		Cedar Falls	4	38	0	16	na	15
22	y		Cedar Falls	2	54	0	21	na	12
23	y	Wapsie Valley	Fairbank	5/6	47	0	25	600	25
24	y		Waterloo	5	56	0	29.5	12000	6
25					45.00		18.10		11.83
26									
27	Returned?	School	City	Grade level	Q1	Q2	Q3	Q5	Q6
28									
29	y	Atlantic Middle	Atlantic	6	27	1	5	1400	5
30	y	Woodrow Wilso	Newton	4	24	1	2	na	2
31	y	Tipton El.	Tipton	5	42	1	4	840	4
32	y	West Middle	Anamosa	6	52	1	31	1200	16
33	y	North Cedar	Cedar Falls	6	25	1	2	na	2
34	y		Cedar Falls	4	41	1	20	na	18
35					35.17		10.67		7.83
36									
37									

	J	K	L	M	N	O	P	Q	R
1	Title k-3: 2;	20	15	15	15	15	15	none	1
2	Middle School: 1;	22	30	30	30	30	30	30/day	0
3	k-6MD-SCI: 6;	24	45	45	45	45	45	none	0
4	0	20	40	40	40	40	40	none	1
5	high school: 3	150	45	45	45	45	45	none	0
6	4th: 13	21	0	60	0	60	0	na	1
7	6-7-8, 4-5	23	50	50	50	50	50	50-55	0
8	3rd: 2.5; 4th: 2	na	30	30	30	0	0	none	1
9	0	21	30	30	30	30	30	90 min/week	1
10	1st: 3	16	20	20	20	20	20	none	0
11	Kdg: 10; PreK: 8	15	20	20	20	20	20	none	0
12	6th: 12; 7/8: 5	21	42	42	42	42	42	210 min/week	1
13	0	19	30	30	30	30	30	2.5 hrs/week	1
14	3rd: 2	22	40	40	0	40	30	60 min 3 times	0
15	0	22	40	30	40	30	40	none	0
16	12345	20	30	30	45	0	30	none	1
17	1st: 2, 2nd: 8,	22	35	35	35	35	35	90 min/wk	1
18	4/5: 3	27	43	43	43	43	43	43/day	0
19	0	23	0	45	45	0	45	none	[illegible]
20	0	116	230	230	230	230	230	230/day	[illegible]
21	6th:1	20	30	45	45	0	45	150/week	[illegible]
22	Sp. Ed k-6: 8;	22	30	45	30	60	30	30/day	[illegible]
23	0	19	30	30	30	30	0	none	[illegible]
24	2nd: 11; 6-8: 1;	28	55	55	0	55	55	45/day	[illegible]
25		31.00	40.00	45.21	39.17	39.58	39.58		13.00
26									54.17%
27	Q7	Q8	Q9a	Q9b	Q9c	Q9d	Q9e	Q10	Q11 (Y/N)
28									
29	na	28	42	42	42	42	42	42 min/day	[illegible]
30	0	24	45	45	30	45	45	30-45	[illegible]
31	0	22	45	0	45	0	45	none	[illegible]
32	5th: 15	116	18	18	18	18	18	90/week	[illegible]
33	0	20	60	30	30	0	30	na	[illegible]
34	5th: 1; adult	21	45	45	45	0	30	na	[illegible]
35		38.50	42.50	30.00	35.00	17.50	35.00		4.00
36									66.67%
37									

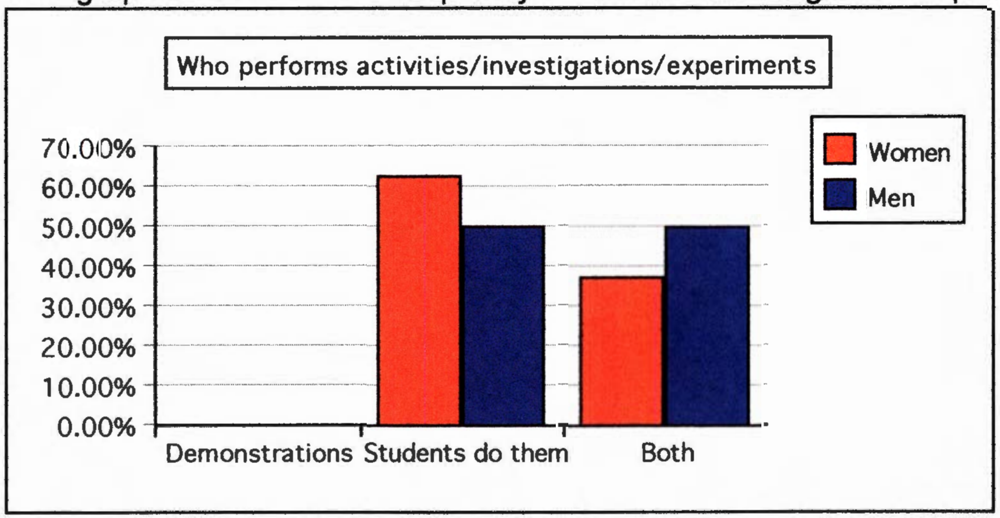
	S	T	U	V	W	X	Y	Z	AA
1	2	1	1	0	0	0	0	6	y
2	1	1	1	1	1	0	0	5.5	y
3	1	1	1	1	2	0	0	10	y
4	1	1	1	0	0	0	0	5	y
5	5	2	1	1	6	0	0	9	y
6	4	0	1	1	2	0	0	8	y
7	5	1	3	0	0	0	0	10	y
8	2	0	0	0	0	0	0	8	y
9	1	0	1	1	2	1	1	9	y
10	4	2	0	1	2	0	0	9	y
11	1	0	1	1	1	0	1	7	y
12	0	0	0	1	1	0	1	7	y
13	1	0	0	0	0	0	0	6	y
14	3	2	0	1	1	0	0	6	y
15	4	1	1	1	2	1	3	8	y
16	1	0	2	1	0	0	2	9	y
17	1	1	1	0	0	0	0	9	y
18	3	3	1	1	1	0	0	3	y
19	2	1	1	1	6	0	0	7	y
20	2	2	1	0	0	0	0	7	y
21	1	0	0	1	3	1	2	10	y
22	2	1	0	1	1	0	1	10	y
23	1	0	0	1	6	6	0	7	y
24	5	0	3	0	0	0	0	10	y
25	2.21	0.83	0.88	16.00	1.54	0.38	0.46	7.73	
26				66.67%					
27	Q11a	Q11b	Q11c	Q12 (Y/N)	Q12a	Q12b	Q12c	Q13	Q14
28									
29	2	1	3	0	0	0	0	8	y
30	1	1	1	0	0	0	0	7.5	y
31	5	3	3	0	0	0	0	10	y
32	3	2	2	1	6	2	3	9	y
33	3	3	3	1	1	0	1	10	y
34	4	0	0	1	4	0	0	10	y
35	3.00	1.67	2.00	3.00	1.83	0.33	0.67	9.08	
36				50.00%					
37				(1=Y, 0=N)					

	AB	AC	AD	AE	AF	AG	AH	AI
1	b	c	a	a,d	all	n/a	time.	choosing
2	c	c	b,c	a,b,c,d	all	n/a	not	involve
3	a	b	na	c	specialize	Science and Eng	none	Love to
4	b	c	c	c,d	specialize	Math and Scienc	new texts	rich
5	a	b	a,b,c	a,b,c,d	specialize	science	chemistry	life science
6	c	b	a	a,b,c	all	n/a	time	make it
7	a	c	c	b,d	specialize	science	none	Earth.
8	c	c	a,c	a,b,c,d	all	n/a	time; knowing	enjoy science
9	a	b	a,b,c	a,b,c,d	all	n/a	upper level	elementary
10	b	c	b	b,c	all	n/a	physical	life science
11	a	b	b	a,b,c,d	all	n/a	Time	more
12	b	b	b	a,b,c,d	specialize	science, math	applying to	curiousity and
13	a	c	a,b,c	a,b,c	all	n/a	not spent	use
14	c	c	a,c	a,c	all	n/a	not enough	open to new
15	a	b	b	a,c	all	n/a	length of unit;	hands-on;
16	a	c	b	a,b	all	n/a	materials.	interest.
17	a	b	b	b,c,d	all	n/a	time.	attend
18	a	b	b	a	all	n/a	content	fun; easy to
19	a	b	c	b	all	n/a	background in	enjoy
20	c	b	b	a,b,c,d	specialize	science	staying up to	variety:
21	a	b	a,b,c	a,b,c,d	all	n/a	time	integrating
22	a	b	a,b	b,c,d	all	n/a	time	knowledge of
23	a	b	b	a,b,c,d	specialize	math and scienc	small room;	enthusiasm
24	a	b	b	a,b,c,d	specialize	language, math	time;	comfort with
25								
26								
27	Q15	Q16	Q17	Q18	Q19	Q20	Q21	Q22
28								
29	a	c	a,b,c	a,b,c,d	specialize	science, social	physics	life science
30	a	c	a,c	a,b,c,d	all	n/a	too much to	let students
31	a	b	c	c	all	n/a	not enough	large
32	c	b	b	a,b,c,d	all	chemistry/phy	astronomy.	
33	a	c	b	b,c	all	n/a	time	good content
34	a	b	b,c	a,c	all	n/a	solar system	great mentors;
35								
36								
37								

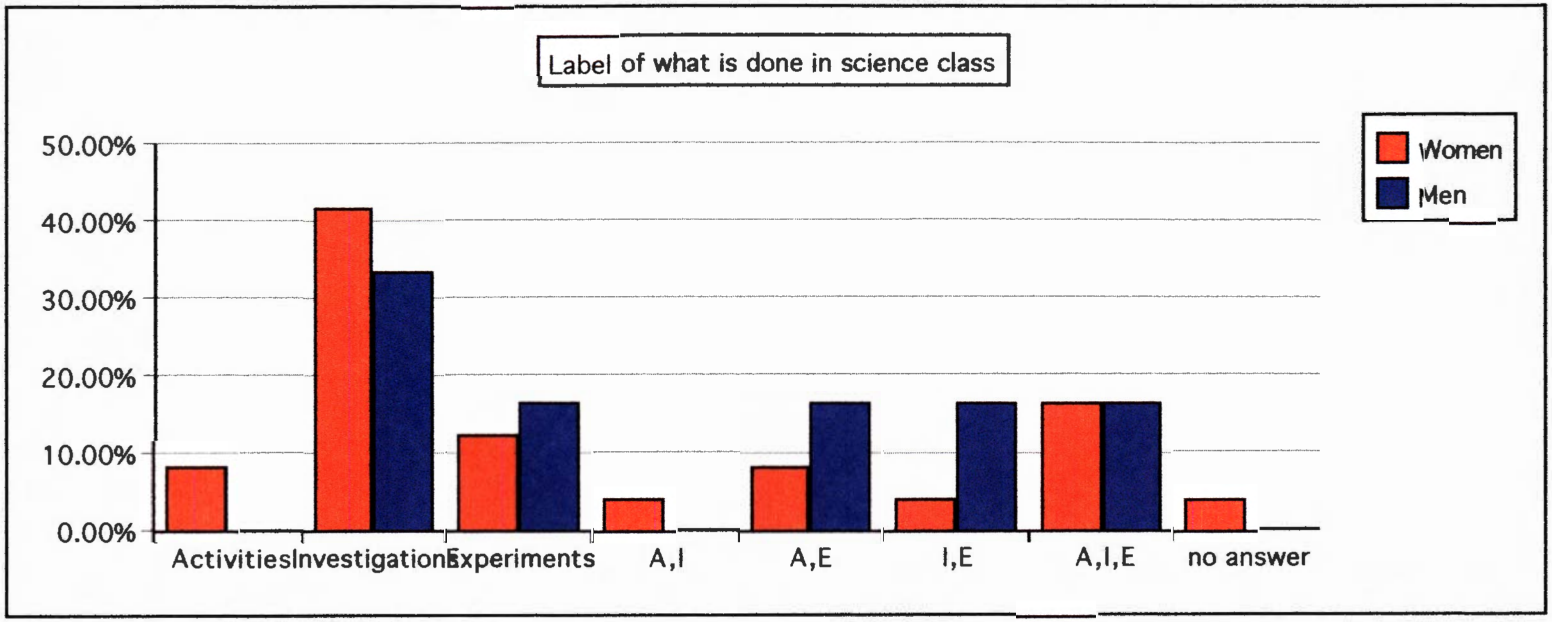
GENDER: N of red=24; N of blue=6



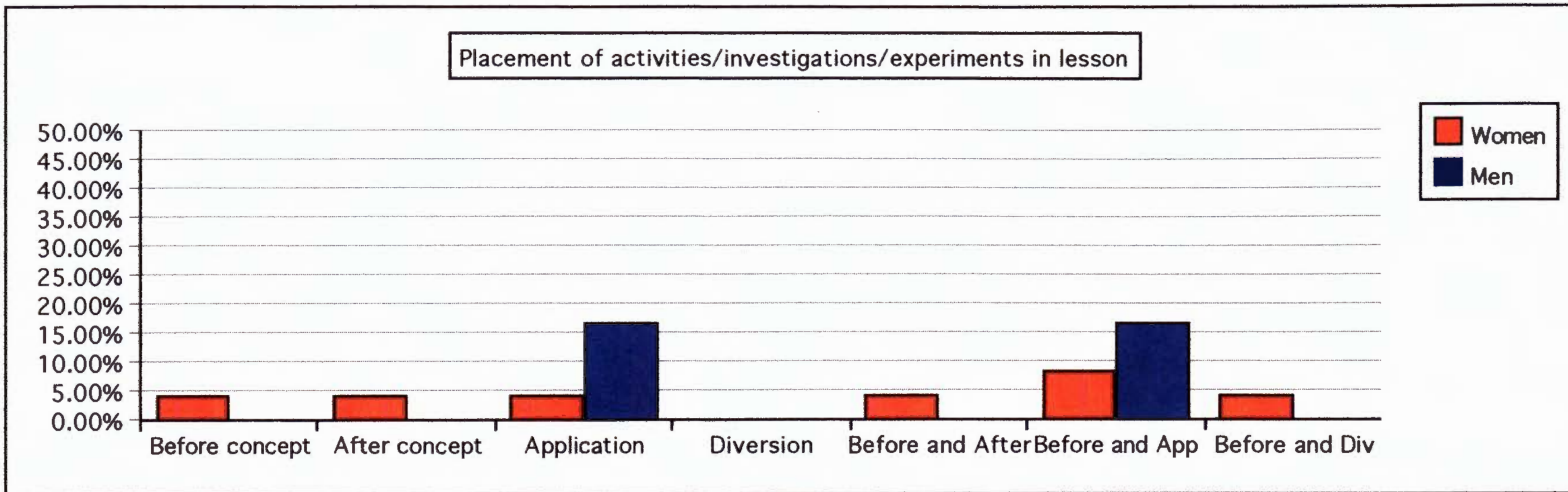
This graph shows how the frequency of activities/investigations/experiments is affected by gender.

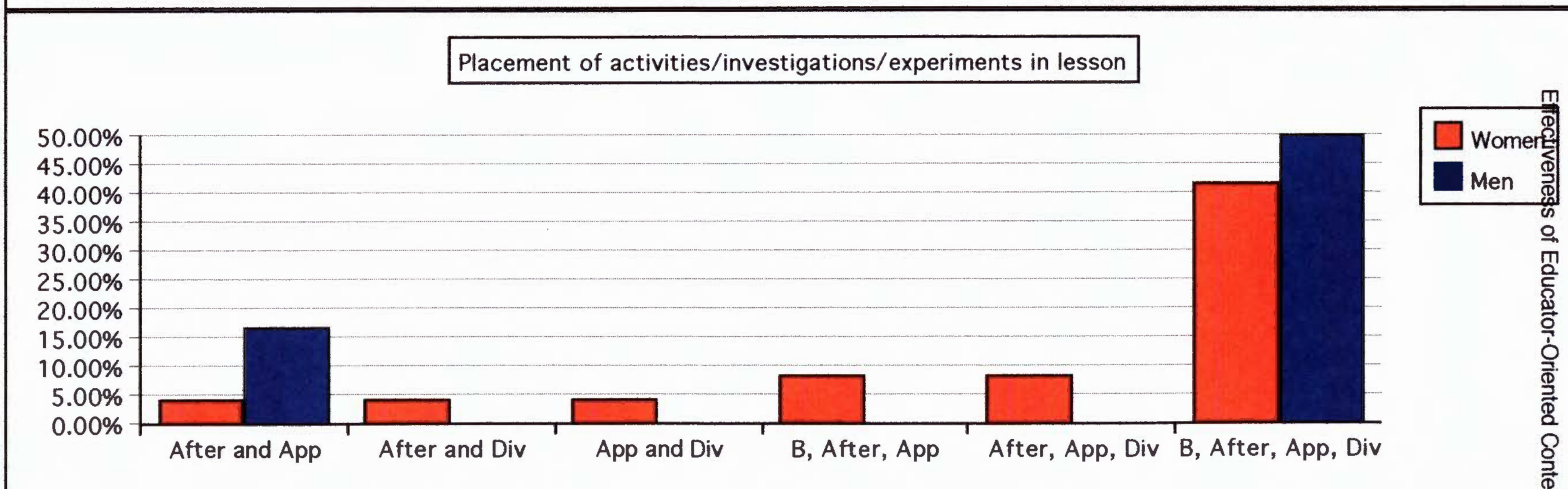


This graph shows how gender affects who performs the activities/investigations/experiments.



This graph shows how the label of what is done in science class is affected by gender.





These two graphs show how the placement of activities/investigations/experiments is affected by the gender of the educator.

Appendix F:
Educator-Oriented Content Courses Data

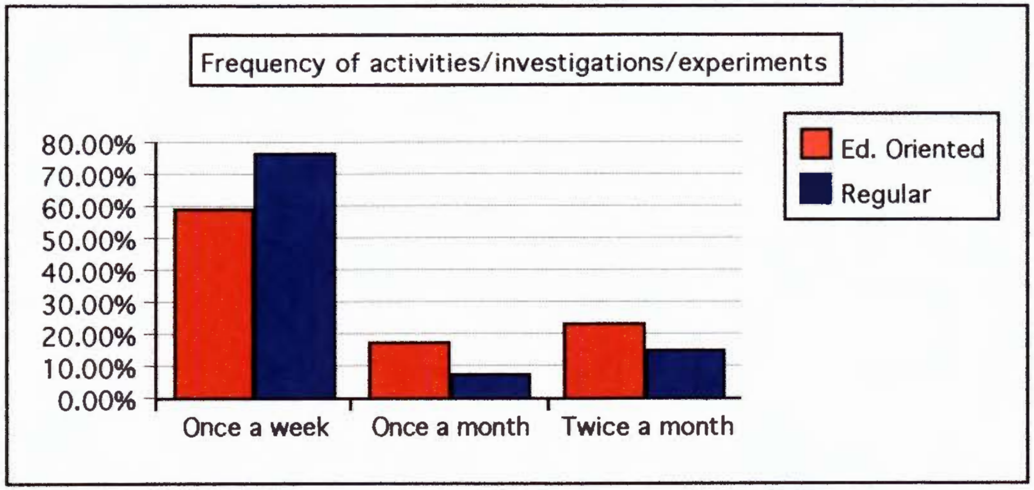
	A	B	C	D	E	F	G	H	I
1	EOCC	Shenandoah El.	Shenandoah	3	47	0	20	na	12
2	EOCC	Mount Ayr El.	Mount Ayr	5	24	0	2	700	2
3	EOCC	Atlantic Middle	Atlantic	6	27	1	5	1400	5
4	EOCC	Woodrow Wilso	Newton	4	24	1	2	na	2
5	EOCC	Mediapolis El.	Mediapolis	3/4	42	0	18	900	5
6	EOCC	North El.	Storm Lake	2	na	0	12	na	7.5
7	EOCC	Kinsey El.	Sioux Center	2	40	0	18	800	18
8	EOCC	Prairie Valley M	Gowrie	5	43	0	19	850	2
9	EOCC	North El.	Hampton	2	25	0	2.5	1300	2.5
10	EOCC	West Middle	Anamosa	6	52	1	31	1200	16
11	EOCC	Cedar Falls	Cedar Falls	2	37	0	15	na	4
12	EOCC		Waterloo	3	58	0	37.5	420	25
13	EOCC	North Cedar	Cedar Falls	6	25	1	2	na	2
14	EOCC		Cedar Falls	4	57	0	30	376	30
15	EOCC	Independence C	Independence	6	45	0	4	1550	4
16	EOCC		Cedar Falls	4	38	0	16	na	15
17	EOCC	Wapsie Valley	Fairbank	5/6	47	0	25	600	25
18					39.44		15.24		10.41
19									
20	Content Courses	School	City	Grade level	Q1	Q2	Q3	Q5	Q6
21									
22	Regular	West Ridge El.	Harlan	4	48	0	28	1700	23
23	Regular	AHST Middle	Avoca	5	46	0	24	600	13
24	Regular	Elk Horn-Kimba	Elk Horn	6	42	0	7	312	4
25	Regular	Smart Intermec	Davenport	6	58	0	18	700 @ school	18
26	Regular	Ruthven-Ayrsh	Ruthven	2	53	0	26	300	23
27	Regular	Sentral El.	Fenton	2	57	0	27	280	9
28	Regular	McKinstry El.	Waterloo	4	28	0	4	na	2
29	Regular	Tipton El.	Tipton	5	42	1	4	840	4
30	Regular	Dike-New Hartf	Dike	5	40	0	16	787	16
31	Regular	Janesville	Janesville	6	50	0	15	250	6
32	Regular		Cedar Falls	2	54	0	21	na	12
33	Regular		Waterloo	5	56	0	29.5	12000	6
34	Regular		Cedar Falls	4	41	1	20	na	18
35					47.31		18.42		11.85
36									
37									

	J	K	L	M	N	O	P	Q	R
1	Title k-3: 2;	20	15	15	15	15	15	none	1
2	0	20	40	40	40	40	40	none	1
3	na	28	42	42	42	42	42	42 min/day	1
4	0	24	45	45	30	45	45	30-45	1
5	4th: 13	21	0	60	0	60	0	na	1
6	3rd: 2.5; 4th:	na	30	30	30	0	0	none	1
7	0	21	30	30	30	30	30	90 min/week	1
8	6th: 12; 7/8:	21	42	42	42	42	42	210 min/week	1
9	0	19	30	30	30	30	30	2.5 hrs/week	1
10	5th: 15	116	18	18	18	18	18	90/week	1
11	12345	20	30	30	45	0	30	none	1
12	1st: 2, 2nd: 8,	22	35	35	35	35	35	90 min/wk	1
13	0	20	60	30	30	0	30	na	1
14	0	23	0	45	45	0	45	none	1
15	0	116	230	230	230	230	230	230/day	1
16	6th:1	20	30	45	45	0	45	150/week	1
17	0	19	30	30	30	30	0	none	1
18		33.12	41.59	46.88	43.35	36.29	39.82		
19									
20	Q7	Q8	Q9a	Q9b	Q9c	Q9d	Q9e	Q10	Q11 (Y/N)
21									
22	Middle School:	22	30	30	30	30	30	30/day	0
23	k-6MD-SCI: 6;	24	45	45	45	45	45	none	0
24	high school: 3	150	45	45	45	45	45	none	0
25	6-7-8, 4-5	23	50	50	50	50	50	50-55	0
26	1st: 3	16	20	20	20	20	20	none	0
27	Kdg: 10; PreK:	15	20	20	20	20	20	none	0
28	3rd: 2	22	40	40	0	40	30	60 min 3 times	0
29	0	22	45	0	45	0	45	none	0
30	0	22	40	30	40	30	40	none	0
31	4/5; 3	27	43	43	43	43	43	43/day	0
32	Sp. Ed k-6: 8;	22	30	45	30	60	30	30/day	0
33	2nd: 11; 6-8:	28	55	55	0	55	55	45/day	0
34	5th: 1; adult	21	45	45	45	0	30	na	0
35		31.85	39.08	36.00	31.77	33.69	37.15		
36									
37									

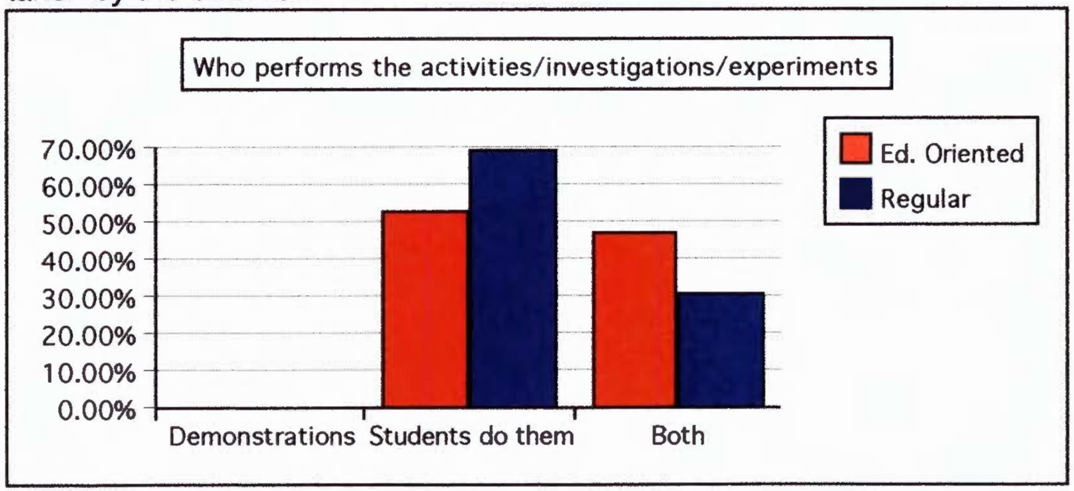
	S	T	U	V	W	X	Y	Z	AA
1	2	1	1	0	0	0	0	6	y
2	1	1	1	0	0	0	0	5	y
3	2	1	3	0	0	0	0	8	y
4	1	1	1	0	0	0	0	7.5	y
5	4	0	1	1	2	0	0	8	y
6	2	0	0	0	0	0	0	8	y
7	1	0	1	1	2	1	1	9	y
8	0	0	0	1	1	0	1	7	y
9	1	0	0	0	0	0	0	6	y
10	3	2	2	1	6	2	3	9	y
11	1	0	2	1	0	0	2	9	y
12	1	1	1	0	0	0	0	9	y
13	3	3	3	1	1	0	1	10	y
14	2	1	1	1	6	0	0	7	y
15	2	2	1	0	0	0	0	7	y
16	1	0	0	1	3	1	2	10	y
17	1	0	0	1	6	6	0	7	y
18	1.65	0.76	1.06	9	1.59	0.59	0.59	7.79	
19				52.94%					
20	Q11a	Q11b	Q11c	Q12 (Y/N)	Q12a	Q12b	Q12c	Q13	Q14
21				(1=Y, 0=N)					
22	1	1	1	1	1	0	0	5.5	y
23	1	1	1	1	2	0	0	10	y
24	5	2	1	1	6	0	0	9	y
25	5	1	3	0	0	0	0	10	y
26	4	2	0	1	2	0	0	9	y
27	1	0	1	1	1	0	1	7	y
28	3	2	0	1	1	0	0	6	y
29	5	3	3	0	0	0	0	10	y
30	4	1	1	1	2	1	3	8	y
31	3	3	1	1	1	0	0	3	y
32	2	1	0	1	1	0	1	10	y
33	5	0	3	0	0	0	0	10	y
34	4	0	0	1	4	0	0	10	y
35	3.31	1.31	1.15	10	1.62	0.08	0.38	8.27	
36				71.43%					
37									

	AB	AC	AD	AE	AF	AG	AH	AI
1	b	c	a	a,d	all	n/a	time,	choosing
2	b	c	c	c,d	specialize	Math and Scien	new texts	rich
3	a	c	a,b,c	a,b,c,d	specialize	science, social	physics	life science
4	a	c	a,c	a,b,c,d	all	n/a	too much to	let students
5	c	b	a	a,b,c	all	n/a	time	make it
6	c	c	a,c	a,b,c,d	all	n/a	time; knowing	enjoy science
7	a	b	a,b,c	a,b,c,d	all	n/a	upper level	elementary
8	b	b	b	a,b,c,d	specialize	science, math	applying to	curiousity and
9	a	c	a,b,c	a,b,c	all	n/a	not spent	use
10	c	b	b	a,b,c,d	all	chemistry/phy	astronomy,	
11	a	c	b	a,b	all	n/a	materials,	interest,
12	a	b	b	b,c,d	all	n/a	time,	attend
13	a	c	b	b,c	all	n/a	time	good content
14	a	b	c	b	all	n/a	background in	enjoy
15	c	b	b	a,b,c,d	specialize	science	staying up to	variety;
16	a	b	a,b,c	a,b,c,d	all	n/a	time	integrating
17	a	b	b	a,b,c,d	specialize	math and scienc	small room;	enthusiasm
18								
19								
20	Q15	Q16	Q17	Q18	Q19	Q20	Q21	Q22
21								
22	c	c	b,c	a,b,c,d	all	n/a	not	involve
23	a	b	na	c	specialize	Science and Enç	none	Love to
24	a	b	a,b,c	a,b,c,d	specialize	science	chemistry	life science
25	a	c	c	b,d	specialize	science	none	Earth,
26	b	c	b	b,c	all	n/a	physical	life science
27	a	b	b	a,b,c,d	all	n/a	Time	more
28	c	c	a,c	a,c	all	n/a	not enough	open to new
29	a	b	c	c	all	n/a	not enough	large
30	a	b	b	a,c	all	n/a	length of unit;	hands-on;
31	a	b	b	a	all	n/a	content	fun; easy to
32	a	b	a,b	b,c,d	all	n/a	time	knowledge of
33	a	b	b	a,b,c,d	specialize	language, math	time;	comfort with
34	a	b	b,c	a,c	all	n/a	solar system	great mentors;
35								
36								
37								

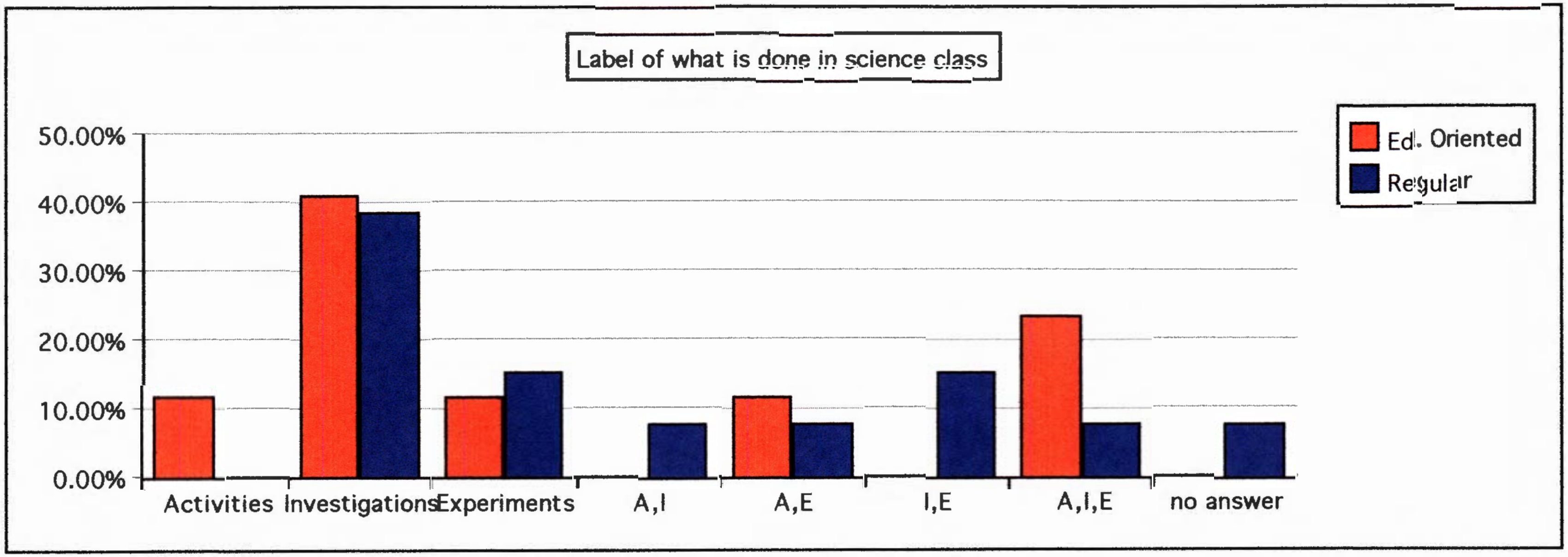
CONTENT CLASSES: N of red=17; N of blue=13



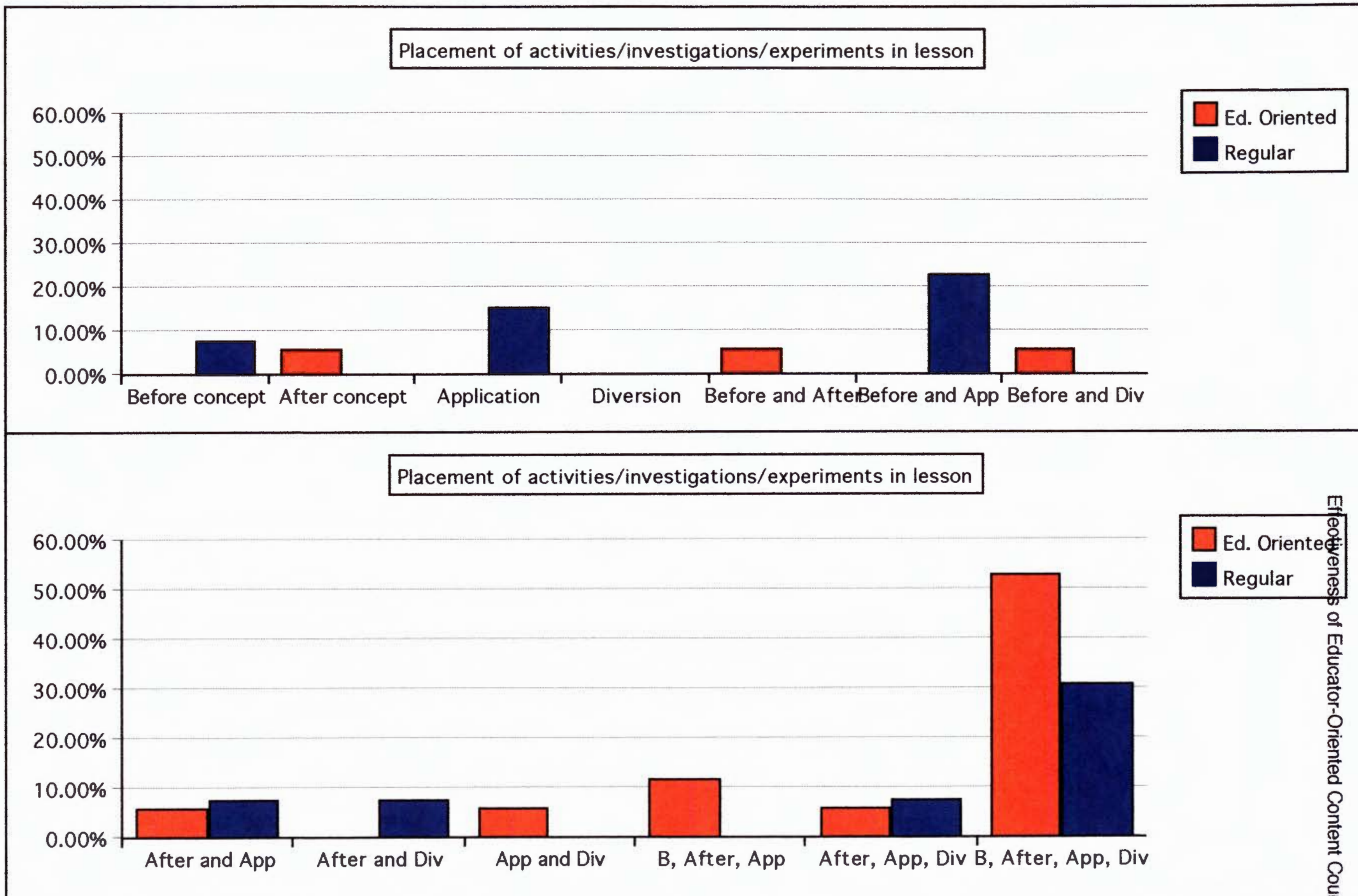
This graph shows how the frequency of activities/investigations/experiments is affected by the science content courses taken by the educator.



This graph shows how the educator*s content courses affect who performs the activities/investigations/experiments in a lesson.



This graph shows how the label of what is done in class changes based on the kind of content courses taken by the educator.



These two graphs show how the placement of the activities/investigations/experiments is affected by the kind of content courses the educator took at the university.